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VIEWS, NEWS AND INTERVIEWS.

The total number of employés in the Thomson-Houston factories on January 1, 1883 was 45. On January 1, 1892, this number had increased to 3,492. The weight of apparatus shipped by this company in 1888 amounted to 8,000,000 pounds. In 1891 these figures had reached 40,000,000 pounds.

A bill has passed the State Senate and is pending in the Assembly which seems to give the New York Board of Electrical Control the power to grant permission to corporations to erect overhead electrical wires. This should be done under the proper consideration for the rights of the lighting companies.

Fräulein Elizabeth Barnewitz, a young Polish telephone girl of great beauty, ran into Mehle's shop for firearms on Thursday and asked for a loaded revolver. Herr Mehle suspected that something was wrong, and loaded the revolver that he sold her with blank cartridges. She went directly to the rooms of her lover, with whom she had quarrelled, but he was out. She crawled under the bed and there fell asleep. When she awoke, her lover was asleep in bed. She crawled out, put the revolver close to his breast, and fired three times. Believing that she had killed him, she ran away, leaving the revolver on the bed. When her lover recovered from the shock he made a complaint which led to her arrest. At her trial Herr Mehle appeared unexpectedly and told the story of the blank cartridges, which was borne out by the full chambers of the revolver which the girl left on the bed. She was discharged from custody by the Police Justice, after having promised to make up her quarrel with her lover.

Henry Guy Carleton's fad, when not engaged in writing plays on the Thompson Street Poker Club, is chemistry and electric experiments.

Mary Hopkins, a mute inmate of the Wayne County almshouse, and between 40 and 50 years of age; was sent there about six years ago. Three years later she suddenly lost her speech. It was decided that she was suffering from paralysis of the vocal cords. The current from an electric battery was applied and after about a month's treatment the matron was surprised, on entering the mute's room one morning, to be greeted by a loud "hello" from Mrs. Hopkins.

"Mr. Thomas A. Edison has given satisfactory assurances that if that double-barrelled electric trust goes through, his talking doll will have nothing to say against it."—*N. Y. Evening Telegram.*

Mr. R. H. Chittenden has recently published some interesting deflections of the magnetic needle during the continuance of a tornado in Minnesota in 1890. His observations showed very clearly that the needle served as a galvanometer to indicate the proximity of the storm cloud one or two hours before its near approach. This is an important line of investigation.

The *Rochester Post*, during the recent meeting at Buffalo, said that the electric light men were discussing everything in their line "from the arc down." Not bad; but not too often, it is getting old.

On the Law of Hysteresis.

ABSTRACT OF DISCUSSION ON MR. CHAS. P. STEINMETZ'S PAPER, READ BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The Chairman asked Mr. Steinmetz if, in his experiments and tests, he had determined whether or not there was any real foundation in fact for the distinction which Professor Ewing has drawn between the molecular friction, which he calls "static hysteresis," and the real time-lag, which he denominated "viscous hysteresis."

Mr. Steinmetz: I really am not yet prepared to answer the question whether viscous or time hysteresis exist or not. My tests in only one set of determinations gave me an increase of hysteretic loss with increasing frequency, which seems to point to the existence of a viscous hysteresis. For if a viscous hysteresis exist, it would show by an apparent increase of the coefficient of hysteresis, with increasing frequency. But most of the tests do not show this, but give the same coefficient of hysteresis for different frequencies. At any rate, if there exists such a time-hysteresis — which I shall try to find out —it follows the law of the 1.6 power also. But, I think, only at much higher frequencies than those I have used in my tests, can we hope to meet with viscous hysteresis. I hope to be able at a future meeting to give more detailed information on this and some other phenomena connected with the magnetic hysteresis.

Mr. A. E. Kennelly said that he had observed the same law in the case of one sample of wrought iron taken by a ballistic method, and another sample of wrought iron taken by wattmeter method, both giving the eight-fifths power, though he did not know what the exact value of the coefficient η was in those particular instances. He thought it very puzzling to understand what that peculiar fraction eight-fifths means. It is rather too high and unwieldy a fraction to be understood at a glance. But whatever its inner meaning may be, its outward and visible indications are clear enough, because if you double the flux density in a piece of iron you will treble the energy which is consumed in it per cycle, by hysteresis, independent of the energy that is consumed in it by eddy currents.

Mr. Steinmetz: This law of hysteresis is of interest from another point of view: We all know, now, that energy is always the same and indestructible, and merely changes its form and appearance, which we call the law of the conservation of energy. But this law of conservation of energy needs a certain restriction or, rather, addition, because every conversion of one form of energy into another is not possible, but only those where the value of a certain integral, called by Clausius the "entropy," is positive, or, in plain English, only those conversions whereby the sum of the latent heat of the universe increases. According to this law of entropy, if the complete conversion of one form of energy into another is possible, the opposite conversion is not completely possible. Or if we convert a certain amount of one form of energy into another form of energy, and this back again into the first form of energy—which we call a cyclic conversion of energy—we do not get back the original amount of energy, but less, and a part of the energy has been lost; that means, converted into and dissipated as heat. Therefore, no complete cyclic conversion of energy exists, but by any such cycle the amount of available energy has decreased by that fraction that was converted into heat.

In none of these cyclic conversions of energy, so far as I know, was the law known which determines and analytically formulates the loss of energy by conversion into heat. The electro-magnetic cycle is the first one wherein the law of hysteresis, this law of dissipation of energy by heat, finds an analytical formulation. In the alternating electro-magnetism we have such a cyclic conversion of energy from electric into magnetic energy and back. Magnetism represents a certain amount of stored up or potential energy. As long as the magnetism increases, electric energy is transferred from the electric current and converted into potential magnetic energy. While the magnetism decreases, potential magnetic energy is reconverted into electric energy, and appears in the electric circuit as electromotive force. But the full amount of energy is not given back to the electric circuit, but less by that amount that has been converted into heat by hysteresis. Hence the law of hysteresis is the dependence of the integral of entropy in the electro-magnetic cycle, upon the intensity of magnetization, and therefore of interest.

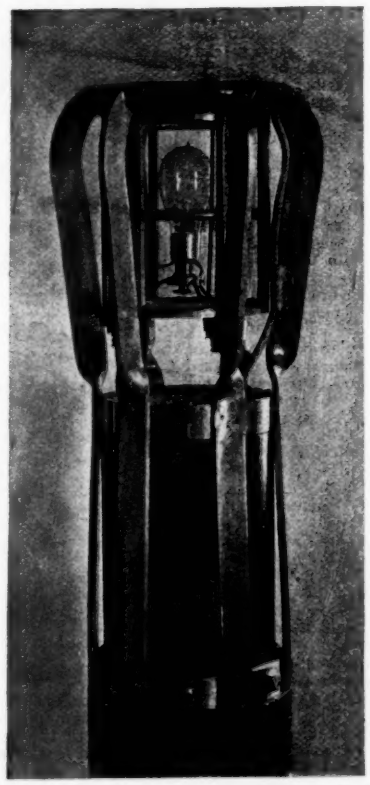


FIG. 1.—HEAD OF ELECTRIC LIGHTED BUOY ADOPTED BY UNITED STATES LIGHTHOUSE BOARD.

Dr. M. I. Pupin agreed that hysteresis is only a special case of the irreversibility of natural processes. It is only a special case of the general law which was first announced by the late Professor Clausius, that the entropy of the universe is tending toward a maximum. As in every process there is a certain amount of energy converted into heat, the amount of heat in the universe is continually increasing. Professor Rankine made a guess as to how many years would elapse before the whole energy of the universe will be converted into heat, when there will be no life, no natural phenomena, excepting heat vibrations. It is very far off yet. Closely connected with magnetic hysteresis is the so-called electro-static hysteresis. Researches in this field have not been carried far enough to speak with definiteness, but it is beyond doubt that if you polarize a dielectric and depolarize it again, a certain amount of heat is developed. One of the obstacles to

(*Continued on page 37.*)

THE PROTECTION OF LIGHT.

ELECTRIC LIGHTING OF BUOYS IN NEW YORK HARBOR.

Comparatively few people, other than those directly interested in the subject, have any idea of the difficulties experienced by vessels desirous of entering the harbor of New York, or of the magnitude of the works established and maintained by the government for the safe guidance and protection of shipping interests in this, America's greatest port of entry.

Standing on the point of Sandy Hook and letting the eye range over the beautiful stretch of water comprising the lower bay, it seems hard to believe that out of the entire distance from that point to the shore of Coney Island, about seven miles, there are only two narrow channels through which vessels of average draught can pass, and only one which can be used by the larger ships, such as the transatlantic steamers.

Such, however, is the case, the entire bottom being covered by treacherous shoals and sandbars, and necessitating the use of no less than 80 buoys, 13 lighthouses and two lightships to mark the dangerous localities and proper channels to be followed.

There are, of course, several channels open to sailing vessels and others of light draught, but of the two principal channels, that known as the "Swash Channel" is the more direct, and is used on that account by most of the coasting vessels and others of medium draught; but the deep draught vessels are obliged to take the longer and less direct route through Gedney's Channel, and it is here that a vast amount of time and money has been expended in making this chief gateway to the city safe and easy of access.

Up to the Fall of 1888, the entrance to Gedney's Channel was practically closed at night, having no distinguishing marks, except unlighted buoys, and although very nearly in range with the Princess Bay Light, near the head of Raritan Bay, this light is at a distance of about 13 miles, and aside from its liability to be obscured in even moderately thick weather, the danger of steering by compass through so narrow a channel, in which the tide constantly varies in strength and direction, was such that vessels arriving after dark preferred to anchor outside the bar and wait for daylight before undertaking its passage.

In 1888, however, in view of the great increase during recent years in the number, draught and speed of ocean steamers entering this port, together with the demands of commerce, the government went into the matter very thoroughly, and a system of improvements was started which to-day, after an expenditure of over $2,000,000, has resulted in opening up a highway to the city 1,000 feet wide, with a depth of 30 feet at mean low water, through which vessels of the deepest draught can safely enter the harbor and proceed at once to their docks, at any hour of the day or night.

Owing to the constant changes in the course of the channel, from the action of the tides, it became a somewhat difficult problem to decide as to what was the best method of clearly defining its limits until

such time as range lights from the shore could be brought to bear accurately enough, and from such points as would ensure the safety of a course depending solely upon them for guidance.

After much careful investigation, and taking into consideration the peculiar requirements of the case, it was finally decided that a buoy in the form of a long spar, having its lower end securely shackled to an anchor or heavy sinker resting on the bottom, would be best adapted to withstand the effects of heavy seas and floating ice, and least liable to be displaced or broken by collisions with passing vessels. This being determined, the next important question was the manner in which the buoys were to be lighted, and here again electricity came promptly to the front. It being clearly demonstrated that electric lights on the buoys would prove entirely satisfactory, so far as the brilliancy of the light itself was concerned, experiments were immediately instituted to give the best means of conveying the current from the shore to the buoys a practical test.

In this emergency the experts of the Bishop Gutta Percha Company, of New York, were consulted, and they lost no time in getting up an armored cable containing two copper conductors insulated with gutta percha, of which an experimental line was laid from the lighthouse depot at Tompkinsville, Staten Island, to a spar buoy near the Robbins Reef lighthouse, a distance of about 6,000 feet. The buoy was fitted with an iron cage at the top, enclosing a heavy glass jar containing the lamp, and, after a variety of tests at different seasons and at varying states of the weather, a system was finally adopted suitable to the conditions prevailing

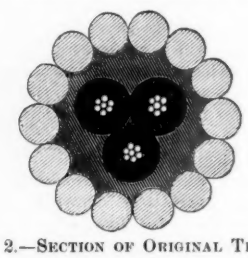


FIG. 2.—SECTION OF ORIGINAL THREE CONDUCTOR CABLE.

in Gedney's Channel, and upon the approval of the Lighthouse Board, the necessary preparations for the erection of a permanent plant were promptly begun, and in November, 1888, the entire system was in operation. In consideration of the fact that the buoys in Gedney's Channel are, at the present time, the only ones in the world lighted by electricity, a few words in relation to the means adopted to accomplish this result may prove of interest. The channel marked by these bouys is 1,000 feet wide and about 6,000 feet long, the inner, or shore end being about 2¾ statute or 2½ nautical miles northeast from the point of Sandy Hook.

Two lines of heavy armored three conductor cables, manufactured by the Bishop Gutta Percha Company, are laid from the Hook Beacon to junction boxes, one on either side of the channel, and situated near the inner buoy on their respective sides. Spliced to these main cables, inside the junction boxes, are three separate single conductor cables of lighter make, connecting the three buoys on either side of the channel, which are located about 2,000 feet apart, with the main line. One of these single conductor cables is spliced at the lower end of each buoy with the cable running up to the lamp, this wire being laid in a deep slot in the side of the buoy, and covered and protected by a strip of wood fitting closely over it and let in flush with the outer surface.

The buoys themselves are about 50 feet long and are made of a species of juniper wood found in the dismal swamp of Virginia, this timber being selected on account of its buoyancy and straightness of growth. They average from 10 to 12 inches in diameter at the top and bottom, and 15½ inches at the largest section, and are shackled at the bottom to a cast-iron sinker, weighing 4,500 pounds.

The protecting cage, in which the incandescent lamp is set, is composed of flat iron ribs, riveted to two iron bands encircling the spar, with a third ring at the top of the cage which serves as a handle. The upper part of the ribs and the top ring are turned so as to present the edge to the lamp, thus securing greater strength and obscuring the light as little as possible.

The lantern itself, which fits securely inside this cage, consists of a circular base and stout framework of brass, having curved panes of thick glass in the sides, and segmented panes at the top. It is so constructed that it can be lifted bodily out of the cage, thereby bringing away everything liable to need repair or other attention. Three short legs attached to the bottom ring fit into holes in brass ears riveted to the ribs, and the lantern is secured in place by two hinged screw clamps, which are also secured to the ribs. The accompanying illustration gives an excellent idea of the appearance of the entire apparatus when in position.

The lamp is rated at 100 candle-power, and the carbon is extra heavy and has three loops in the center, designed to give a distribution of the light as uniform as possible. One terminal wire of the lamp is connected to the bars of the lantern, and the other is carried through an opening having an insulated bushing and connected with the core of the cable. One of the armor wires of the cable is soldered to a rib of the cage to insure a complete circuit through the core of the cable, the lamp and the lantern and frame to the cable armor.

In the first cable laid, which was designed especially for the work by the Bishop Gutta Percha Company, and a cross-section of which is illustrated herewith, the conductor consisted of a strand of seven copper wires of equal diameter, giving a combined cross-section of $\frac{8}{1000}$ of a square inch, and equal in conductivity to a solid wire $\frac{1}{10}$ of an inch in diameter. The conductors were insulated with three coatings of pure gutta percha, and over this was laid a bedding of tarred jute and the armor which, in the three conductor or main cables, consisted of 16 No. 6 B. W. G. wires, and in the single conductor cables of 12 No. 9 B. W. G. wires.

These cables, as originally laid, have given excellent service, and, considering the very hard usage to which they have been subjected, are still in first-class condition. The main difficulty that has been experienced is from mechanical, and, in many instances, malicious injury done the cables, principally from vessels anchoring in or near the channel and getting the cables entangled in their anchors.

In these cases the cable has been lifted from the bottom, and instead of being freed and allowed to drop back into position, has been deliberately chopped through and left for the lighthouse tender to pick up and splice together.

There is no redress to be had for this kind of work, even if the guilty parties are known, as the courts have decided against the cables and in favor of the vessels anchoring, which they continue to do, although warned against it by a large sign on Sandy Hook, which can be seen in the daytime and by a red segment set in the Hook beacon which covers the cable territory at night.

Since the service has been inaugurated, several improvements in minor details, which experience has shown to be of value, have been made, and to-day the entire working of the plant is as near perfection as it can be brought, considering the difficulties to be contended with. The original heavy lantern has been changed for a lighter one, and straight glass has been substituted for the curved panes first used, so that they can be more readily replaced if broken. The lamp is also so adjusted as to enable it to be taken out without removing the entire frame, if necessary, although the lantern can still be lifted out as formerly, if desired.

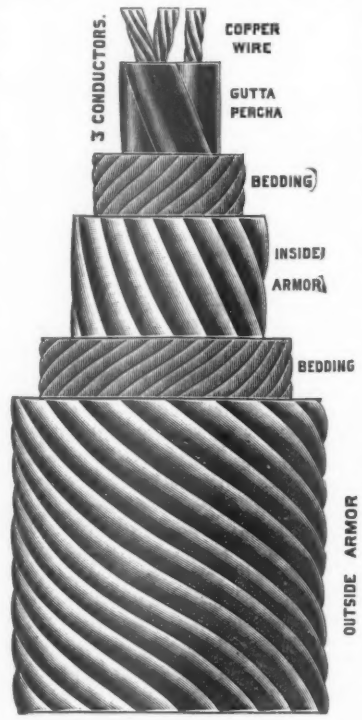
The color of the lights has also been changed, or rather, they have been differently located, those on the starboard side of incoming vessels being now all red and those on the port side all white, instead of alternating, as they were originally.

As an instance of the hard usage to which the buoys and lamps are sometimes subjected, and the excellence of the service rendered under those conditions, it is only necessary to mention that during the severe storm of January last the ice surrounding the lamps was as thick as a good sized barrel, and the weight of this ice, combined with the heavy sea, was sufficient to keep the buoys for the greater part of the time completely under water. In spite of this, and regardless of the mass of ice surrounding them, the lamps continued to burn brightly and without injury, and, as often as they could manage to get their heads above water, were plainly visible from the shore of Sandy Hook, a distance of nearly three miles.

The three years' practical demonstration of the feasibility of this system of lighting, and in view of the excellent results attained therefrom, the only drawback being, as before stated, from mechanical injury to the cable itself, it was decided, a short time ago, by Capt. Henry F. Picking, U. S. N., ranking officer of the Third Lighthouse District, and his able assistant, Lieutenant-Commander C. H. West, under whose supervision the details of the work have been carried out, that in order to insure the best results in the future it would be advisable to substitute a still heavier armored cable than the one now in operation, at least at the channel end of the line, where it was most liable to injury.

Accordingly, the Bishop Gutta Percha Company received an order for about 18,000 feet of new cable which would fill these requirements, and have turned out an article which, it is hoped, will prove durable enough to warrant its adoption throughout the entire system of coast lighting.

The new cable, a longitudinal and cross section of which is here shown, is similar to



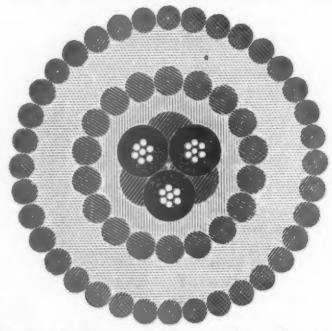


FIG. 3.—LONGITUDINAL AND CROSS SECTION OF LATEST THREE CONDUCTOR CABLE.

the first one in so far as the conductor wires and insulation is concerned, this part having proved entirely satisfactory.

Over the first or inner armor is a bedding of strong tarred hemp saturated with a bituminous compound, designed to keep the zinc of the galvanized wire intact and so prevent rusting. This again is covered by a second iron armor, which is wound on with a "short lay," in order to reduce as far as possible its tendency to kink when dragged from position by the tide, anchors or other causes. When finished the whole cable is treated to a bath of hot bitumen, and is then ready for laying.

After passing Fire Island Light the first objective point of incoming steamers is the Sandy Hook lightship, which is situated eight miles from the point of Sandy Hook and about five miles from the entrance of Gedney's Channel. This entrance is marked by two buoys, one of which is a "nun" and the other a whistling buoy, both being placed here as a means of extra precaution in case one should break loose or be displaced in any manner.

From this point the course is west northwest, one-quarter west, for a mile and a half through Gedney's Channel, and to a point from which an alignment can be obtained with the Point Comfort and Waackaack beacons on the Jersey shore. From here the course is west by south through the main channel for a distance of 3⅛ miles, which brings you inside the Hook and in line with the South Beacon and Sandy Hook Light. A short run, northwest by west, one-quarter west, from here and the Conover and Chapel Hill beacons come into line, and by keeping them directly astern a straight course can be laid to a point just below the Narrows, from whence it is plain sailing through the upper bay and into the North river.

Sandy Hook itself, on which is located the power station for the electric plant, the proving grounds for heavy ordnance and several other important government works, is a sand-bar of most peculiar formation, and the constant changes in its outline from the force of the tides and sea is a source of much trouble and anxiety, especially to the officers of the Lighthouse Board. The strong current from the Hudson coming down the bay is met by that from the Shrewsbury river, and together they sweep past the point of the Hook with a force that cuts away the sand from one place and piles it up in another in the most erratic fashion. A person can stand at one point and jump off into 50 feet of water, while at another it is possible to wade 100 yards from shore without encountering a depth of more than five feet.

The lighthouse authorities are now building a large bell tower as near the point of the Hook as is considered safe, and are putting solid concrete foundations under it, but at the same time have so arranged that it can be moved back at any time if the water encroaches too far, as it is extremely liable to do.

The steam fog horn, which is situated on the eastern side a short distance below the Hook beacon, is now so near the shore that it is considered unsafe, and an appropriation has recently been made to build another plant of the same kind further back, to be used in case of accident to the present one.

These same tide eddies, combined with the heavy swell prevailing off Sandy Hook, furnish a large element of difficulty to be overcome in making repairs to the cables when necessary. This work is generally done from one of the lighthouse tenders, except in heavy weather, when it is customary to use a large cargo boat, as it can be handled more readily and with less danger of breaking the cables. When first laid, and for some time thereafter, the splices were made by the employés of the Bishop Gutta Percha Company, but latterly the men at the station, who from the first have shown great interest in the work, have become so proficient that they are able to handle all the necessary repairs themselves, and this has proved a great advantage, not only in the matter of time and expense, but also from the fact that oftentimes they have been called upon to repair a break in bad weather, and have been able to do the work while tossing on a sea that would compel the average landsman to "give it up," together with whatever else he had with him.

The matter of raising a cable successfully in order to make a splice, is by no means an easy matter, as they are frequently found to be covered with from six to eight feet of sand, causing a very severe strain in raising and requiring great care to avoid breaking. It generally takes about three hours to splice one of the single conductor and four hours for one of the triple conductor cables.

In August, 1889, the Hook beacon on Sandy Hook was connected by wire with the buoy station, and since that time an electric light of 150 candle-power has been used here. This is increased by the lens in the beacon to 3,000 candle power.

The power station on Sandy Hook, from which the current is supplied for the buoys, is a model of efficiency, and no trouble of any kind has been experienced here since the plant has been in operation. Every part of its equipment is of the best, and no effort has been spared to insure the best results. All the working parts are in duplicate, and the failure of the lights through any accident to the steam or electric plant is simply out of the question. The station itself is a compact and substantial brick building, two stories in height, with a one-story brick extension containing the boilers. These, of which there are two, are of the upright tubular type, with a heating surface of 180 square feet and a grate surface of 15 square feet. The average pressure of steam carried is 84 pounds with a daily consumption of 680 pounds of coal. The engines are of the Armington & Sims horizontal automatic type, and for high speed engines are marvels of adjustment, being absolutely noiseless, and running with the regularity of a chronometer. They are of about seven horse-power, the cylinders are six inches in diameter with a seven inch stroke and are run at 380 revolutions per minute.

Running at this speed, a person could stand within two feet of them without being aware, so far as sound is concerned, that there was an engine anywhere in the vicinity.

The entire electrical outfit is of the Edison system, and was furnished by the Edison Manufacturing Company, of New York. The dynamos are continuous current com-

pound wound machines making 1,720 revolutions per minute, and generating a current of 25.5 amperes with an electromotive force at terminals of 160 volts. From the dynamos the wires are led to the testing and switchboard, which is fitted with all the necessary resistances, safety plugs, indicators, testing instruments, etc. From here they pass out and are supported on a line of substantial poles to the beach, a distance of about 1,500 feet, where they are connected to the cables.

The cost of the entire plant, including a naphtha steam launch built purposely for attending the buoys, was $19,530, and the average operating expenses per month are about $400.

The average efficiency of the entire system, taking the total number of lights for every night of their first two years of service, and deducting therefrom the time any of them were out of order, from whatever cause, leaves the percentage of perfect service rendered 93.61, which, on the whole, is a most excellent record. Now that the officers and men at the station have acquired their experience in working the cables and buoys, and the fact that a heavier cable has been laid, which will be less liable to damage, the record for the next two years should be even better than that already shown, and it seems reasonable to infer that the excellent results already obtained will eventually lead to the general adoption of this system of lighting throughout the service.

Accident in the Niagara Falls Tunnel.

Sixty feet of the roof of the Niagara Falls hydraulic tunnel fell on the 2d inst., and seriously injured five of the workmen, one of whom is reported as likely to die. It is stated that the timbering used to support the roof collapsed.

The South Knows Us.

One of the many pleasant reminiscences of the late Convention is the experience related on the train returning from Buffalo, by Mr. Chas. E. Bibber, general manager of the Consolidated Electric Manufacturing Company, of Boston. Mr. Bibber had occasion to go through the South in connection with his business and he desired to consult a certain electrical journal which he had been informed contained something of special interest to him. He went to all the electrical supply dealers and manufacturers in a representative city of the South and requested to have shown him a copy of this certain electrical paper, and met with the universal response that the paper in question was not received, but that they could show him a copy of the ELECTRICAL REVIEW.

PERSONAL.

Lieut. F. B. Badt, of Chicago, was a metropolitan visitor last week.

Mr. Frederic Nicholls, of Toronto, was among the visiting electrical men in New York last week.

Electrical Engineer J. P. B. Fiske now has full charge of the designing and construction of all stationary motors, electric hoists, electric locomotives, etc., for the Thomson-Houston Motor Company. He is one of the bright lights in this field.

Mr. Henry Hine, general manager of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., one of the ablest practical electrical men of the day, was a New York visitor last week, renewing acquaintance with hosts of friends in the metropolis.

Hon. A. B. Uline, vice-president and general manager of the Hudson River Telephone Company, and Col. W. Dunlap Sargent, vice-president and general manager of the New York and New Jersey Telephone Company, leave Thursday of this week on a two months' trip to Nassau and Cuba.

President Daniel F. Lewis, of the Brooklyn City Railroad Company, resumed his duties on Monday morning after a two weeks' absence, during which time he investigated electric equipments in various parts of the country. An order was given for 250 electric motors, but nothing was decided upon as regards engines, which are to be used in various power houses which this company will erect for its extended lines. Mr. Lewis and E. W. Bliss, of the executive committee, traveled in company and covered about 2,500 miles. It was the longest time Mr. Lewis has been absent from his post during the eight years he has been connected with the company. In the electric equipment of the Brooklyn City Railroad many of the cars now running will be utilized, though they will have to be strengthened somewhat, and electricity will be first applied on Hamilton avenue and on Third avenue to Fort Hamilton.—*Brooklyn Life.*

ON THE LAW OF HYSTERESIS.

(*Continued from first page.*)

the commercial introduction of the condenser is its getting hot. Some think it gets hot on account of the convection currents which are passing between the plates of the condenser by means of the air currents and the dust that is in the air; but if you use paraffine so that it will prevent those convection currents, you will observe heat developed in the paraffine which must be attributed to the same cause which develops heat when iron is magnetized and demagnetized; that is hysteresis. Polarization and depolarization of paraffine, and, in fact, any other dielectric, is not a perfectly reversible process.

Dissenting from Mr. Steinmetz, he believed thoroughly in Professor Ewing's view, that in very low magnetizations the act of magnetizing and demagnetizing is practically reversible, and that when a high point of saturation, say, 24,000 or 25,000 lines per square centimetre is reached, the loss due to hysteresis does not increase. After that the iron does not receive any stronger magnetization. The additional lines of force after passing the saturation point are due to the increased magnetization of the air itself, and that magnetization is practically reversible. Mr. Steinmetz had found out an increase, independent of the degree of saturation. He thought there was a discrepancy. Unfortunately, Mr. Steinmetz had not discussed his method so that one can examine it critically.

Mr. Steinmetz: The method used in my tests was the well-known electro-dynamometer method, as explained in the paper, with some slight modifications to insure the greatest possible exactness in the results. With regard to the difference between open circuited and fully loaded transformers (replying to a criticism), I did not say that the wave of the primary *current* in the transformer under *full load* resembles the sine wave more than with *open circuit*, for that would have been wrong. What I said was, that the wave of the *magnetism* and of the *resulting* magneto-motive force in the transformer under full load resembles more the sine wave than it does in the open circuit transformer.

Suppose the impressed electromotive force at the terminals of the transformer differs from the sine shape, differs even considerably; then the primary current, which at open circuit represents the resulting magneto-motive force, will differ much less from the sine shape than the impressed electromotive force, being smoothed out and rounded off to a very great extent by the heavy self-induction of the open circuit transformer. For in the moment of any sudden rise of the impressed electromotive force already a small rise of the primary current and, therefore, of the magnetism will induce sufficient counter electromotive force to make a rapid increase of the primary current impossible.

Hence, in the open circuited transformer, the wave of the magnetism will resemble the sine wave more than the wave of impressed electromotive force. But, nevertheless, it must differ from the sine wave if the impressed electromotive force differs from sine shape.

Quite different in the transformer at full load. Indeed, its apparent self-induction is essentially decreased and the primary current will, therefore, resemble the shape of the impressed electromotive force, and differ from the sinusoidal form, much more than for open circuit.

But at full load the wave of magnetism and of resulting magneto-motive force is much more independent of that of primary current and primary electromotive force. It is caused by the combined action of the instantaneous values of primary and of secondary current, and the secondary current, again, is induced by the magnetism. Hence, the result will be, if a sudden change of impressed electromotive force occurs and produces a sudden change of primary current, just as suddenly as the opposite change of the secondary currents will take place, so that the resultant magneto-motive force of both combined currents will not change perceptibly, but practically independent of either current, will alternate freely in sinusoidal waves, in spite of any difference in the wave shape of primary and secondary current from the sine law.

Mr. Kennelly suggested that it would be preferable to employ the word impedance, instead of inductance, because an inductance is a henry and an impedance is an ohm, and he thought it a pity to confuse the two ideas.

Mr. Steinmetz: I intentionally used the term *inductance*, following a proposition

$$E_1 = R\ C$$

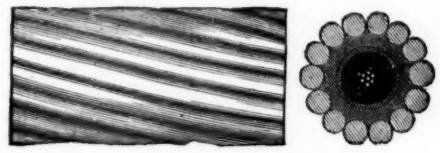


FIG. 4.—SINGLE CONDUCTOR CABLE.

which I read once, I do not remember where, but which seemed to me so highly commendable, that I should like to see it introduced in practical engineering. Indeed, the "coefficient of self-induction" gives all the information needed for determining the electric phenomena in inductive circuits. But everybody will concede that it is a tedious, cumbersome work, from the "coefficient of self-induction" to calculate, for instance, the instrument corrections for a whole set of tests made with somewhat differing frequencies. Besides, I think it will be some time before the "practical electrician" will handle the "coefficient of self-induction" just as easily as he now does ohms and amperes. Let us consider somewhat closer the phenomena in an inductive circuit. If a sine wave of alternating current flows through an inductive circuit, a certain electromotive force is consumed by opposing electromotive forces.

First, by the electric resistance of the circuit, an electromotive force E_1 is consumed, which is proportional to the current C, with a coefficient of proportionality, R, which is called the true or ohmic resistance, or, in short, the *resistance* of the circuit.

This electromotive force is of *equal* (but opposite) phase with the current C:

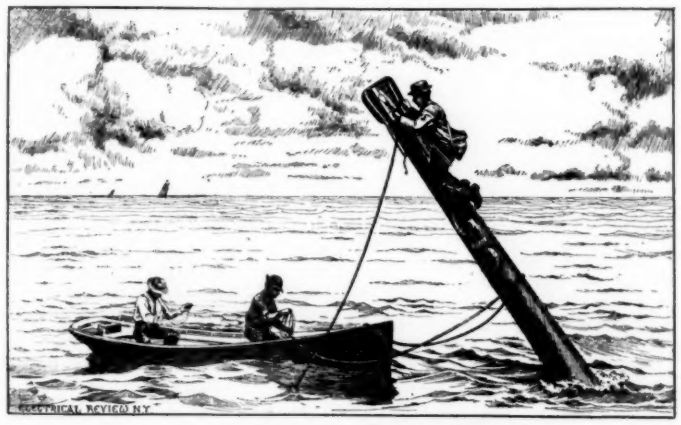


FIG. 5.—TENDING AN ELECTRIC BUOY.

Then by the action of the changing magnetic field of the circuit an electromotive force, E_2 is consumed, which lags one-quarter of a phase, or 90 degrees, behind the current, and is proportional to the current C, with a coefficient of proportionality I, which I call the *inductance* of the circuit.

$$E_2 = I\ C$$

This inductance, I, is of equal dimension with the resistance R, hence measured in ohms also.

This inductance, I, is proportional, also, to the frequency of the alternating current. Hence, if I call the inductance for 100 complete periods per second the *normal inductance* I_0, for any other frequency N the inductance is simply

$$I = \frac{N}{100} I_0$$

Now, the "normal inductance" is a constant of the circuit just as well as the "resistance" or the "coefficient of self-induction," and only depends upon the latter by the equation,

$$I_0 = 200\ \pi\ L,$$

only that "inductance" is measured in ohms also, therefore most easily combined with the resistance.

The combination of the *resistance*—which determines the electromotive force of equal phase with the current—with the inductance, which determines the electromotive force lagging one-quarter phase behind the current, is the "impedance," or "apparent resistance."

Hence,

$$\text{Impedance} = \sqrt{(\text{Resistance})^2 + (\text{Inductance})^2}$$

The quotient of inductance and resistance is the angle of difference of phase between current and impressed electromotive force.

$$\tan \varphi = \frac{\text{Inductance}}{\text{Resistance}}$$

You see, it is easy to make a person understand that he has in an alternating current circuit two kinds of resistances, a "resistance" which consumes energy and an "inductance" which does not consume energy, and make him calculate the apparent resistance or "impedance" as the hypothenuse of a right-angled triangle, with resistance and inductance as catheds; while the coefficient of self-induction will frighten the "practical man" still for quite a while.

On the other hand, "inductance" is more convenient than "coefficient of self-induction," because expressed in the same dimensions as resistance, in ohms.

I used the term "normal inductance," because in reducing the readings I found it much more convenient than the use of the "coefficient of self-induction," and, therefore, recommend its use.

Nebraska City, Neb.—The Water and Light Company of Nebraska City; capital, $300,000. Promoters, E. E. Anderson, T. T. L. Watson, W. S. Downs.

South Creede, Colo.—The Creede Electric Light and Power Company; capital stock, $50,000. Promoters, Jno. H. Poole, Wm. S. Barber, Jno. F. Flintham.

Little Falls, N. Y.—The Little Falls Electric Light and Power Company; capital, $30,000. Promoters, James H. Ives, W. F. Lansing, Geo. O. Oppel.

Highlands, Colo.—The Longmount Electric Light and Power Company; capital, $50,000. Promoters, Robert H. Porter, Irving R. Darrow, E. A. Arbuckle.

New York City.—Wright Universal Electric Company, (incorporated in W. Va.); capital stock, $5,000,000. Promoters, Wm. Wright, Julius Hirshfield and Andrew Morison, of New York.

Buffalo, N. Y.—Buffalo and Niagara Falls Electric Light and Power Company; capital, $100,000. Promoters, Geo. Urban, Jas. A. Robart, Daniel O'Day, Edward Michael and S. E. Muchey, of Buffalo, N. Y.

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Knightstown, Ind.—Knightstown Electric Light Company; capital, $10,000. Promoters, Geo. W. Williams, John S. Patterson, S. E. Test and Harry Watts. Incorporation papers sent to G. W. Williams, Knightstown, Ind.

Seattle, Wash.—Union Electric Company; capital, $1,000,000. Promoters, J. M. Frink, C. P. Stone, Jas. McWilliams, M. L. Wright and T. H. Tyndale, Seattle, Wash. Incorporation papers sent to E. C. Kilbourne, P. O. box 506, Seattle, Wash.

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The competent electric railroad engineer is not found wanting a job these progressive days. Any street railway manager who is not studying the question of electric traction with a view to turning his horses into pasture and adopting electricity is not alive to the signs of the times.

The man fitted by ability, integrity and experience for the presidency of the consolidated Edison and Thomson-Houston interests is Chas. A. Coffin, of Boston. If he is willing to accept, the appointment should be made and would carry with it a confidence that no new and unfamiliar name could possibly possess.

A few more of the many kind words about its Decennial Number are published in the REVIEW. Subscribers say they like the REVIEW, and will read it 'till "Gabriel blow his trumpet," and patrons of our advertising columns endorse it as a particularly valuable medium. These are things that all should make a note of.

A membership in the National Electric Light Association carries with it immunity from the dangers of the ordinary mortals. Witness the falling of the roof of the Niagara Falls tunnel on the 2d inst., only six days after the visit of some 300 members to this work. It is now stated that there is danger of the entire roof collapsing.

The Decennial Number of the ELECTRICAL REVIEW, issued February 20, 1892, met with a welcome that was almost overwhelming. Although the price, 25 cents per copy, was two and one-half times our regular price, the demand for it has been unprecedented in electrical journalism, and every mail to us is freighted with orders, congratulations and well wishes of a tone that leaves no doubt of the sincerity of the writers.

We think the Decennial Number will become of greater value as the years pass, and every electrical library in this country and Europe should have one. Although we printed an immense edition, orders already in would indicate that the demand will overtop our expectations; therefore, every one desiring a copy of this number should order without a moment's delay.

It is likely that Philadelphia will soon grant some of the traction companies permission to change from horses as motive power and put up trolley wires, and the probabilities are that inside of a year all the street car lines in the Quaker city will be operated by electricity.

Notwithstanding all the ancient "arguments" that are so often resuscitated to do duty as stock bugaboos, the "trolley" seems to win its way with a persistency that is admirable.

We would call the attention of our readers to an interesting article on the electric lighting of buoys, which is published in this issue. When the immense amount of ocean, river and harbor traffic centering in New York harbor is remembered, any work which adds to its safe conduct becomes of interest. The electric current, as usual, has been called upon to play its part in this instance, and an important part it is, too. The government officers who have had in charge the experiments of lighting buoys by electricity have attained success in their efforts, and we may now look for important developments in the adaptation of this valuable innovation to all our large harbors and many ports.

The decision of the National Electric Light Association to hereafter hold but one meeting a year is a wise one. In the early days of the Association it was advisable, and almost necessary, to hold semi-annual meetings, in order that the great amount of pioneer work required could be accomplished. Now that this organization is a sound and firmly established institution, and considering that time is so valuable an element to the central station man, one meeting a year to which nearly every one can come seems to be the proper thing. The National Electric Light Association is doing a noble and influential work and is enjoying the pleasure of success. Now is a good time for central station men to join its ranks.

The hazy ideas that many people have of the character of the electric current was exemplified the other day by the defense set up in a suit which the Municipal Electric Lighting and Power Company, of St. Louis, brought against an individual whom they allege stole current from their circuit by using a shunt across the wire to the meter. The defendants raised the point that "*electricity cannot be stolen inasmuch as to steal there must be transportation, which is impossible in the case of electricity, as it is not in any wise under control, and, therefore, not the goods, property or effects of any one.*" The Judge adjourned the case in order to thoroughly consider the matter. The fact that the Judge could not render a decision without leaving his seat shows either that the wording of the law concerning theft in Missouri is very defective, or that His Honor would do well to consult some primer of electricity at once. Electricity is a manufactured product and just as much property, in the fullest sense of the term, as is flour, illuminating oil, or any commodity which requires the expenditure of money, brains and labor in its production.

ALTERNATING CURRENT MOTORS.

It will pay those who are interested in transmission of power by alternating currents to read the admirable paper of William Stanley, Jr., published in this issue of the ELECTRICAL REVIEW. It contains an instructive discussion of the difficulties which surround a successful alternating current motor. It also describes in detail the condenser motor patented by Messrs. Stanley and Kelly, a short description of which was published in the ELECTRICAL REVIEW for July 25, 1891. Mr. Stanley promises that at an early date a rotary current motor operated from a single two-wire alternating current circuit—the joint invention of himself and Mr. Kelly—will appear. They have discovered means of phasing or splitting a simple alternating current so that a rotation of magnetism can be effected from energy furnished by a two-wire circuit. Such a motor would undoubtedly meet with a warm commercial reception if possessed of high efficiency. Presumably this is a commutatorless motor. Efficient alternating motors having commutators have already been produced. In the REVIEW of October 3, 1891, was described a motor invented by Mr. Charles S. Bradley, whose name is familiar in alternating current work. A clever feature of this invention was the elimination of self-induction by raising the counter-electromotive force of the armature circuit. It is said that the self-induction can be entirely eliminated from the armature by this method and that the motor operates with high comparative efficiency. A hard knot to untangle in commutated motors operative under the great fluctuations of electromotive force present in an alternating circuit is the spark and heat at the commutator, and herein resides a feature of great value in the so-called rotary current motor—the magnetism rotates without commutation—and the circuits are never opened except to start up or shut down. With such motors, as generally designed by the various inventors—Tesla, Bradley, Dobrowolsky and Haselwinder—more than two wires are needed to deliver the energy over the line and to the motor circuits.

A plan has been proposed by which a simple alternating current delivered by two wires is lagged by a transformer and the lagged current used in combination with the main current to create a rotation of magnetism. What method Mr. Stanley pursues remains to be seen. It has been claimed by Dobrowolsky that the three-wire alternating system does not require a greater amount of copper in proportion to energy delivered at the motor shaft than the two-wire direct. It would be interesting to know whether the claim is unassailable. If correct, the two-wire system would not offer any advantages unless the motor can be operated with as high an efficiency as a polyphase motor—since the only saving would exist in the expense of the support and maintenance of the third wire upon line.

An interesting portion of the paper and discussion is that relating to the much maligned synchronous motor. No one has yet shown, so far as we know, that the synchronous motor does not offer a perfectly practical solution of the problem of transmission of power when large units are to be handled. The over-loading bugbear should be ruled out of court. If the machines are of a capacity to meet the maximum demand, obviously they cannot be thrown out of step; and it is an easy matter to start them by gradually climbing from zero to working speed. In reality the engine is responsible for the difficulties met with in synchronous motors, rather than the motor itself. If the movement of the engine were perfectly uniform, much of the trouble would disappear. For small units or local service, where the load may vary within wide limits, these motors without torque regulation and starting devices would be barred.

The alternating motor is a broad-gauged question. Let us have a few more papers like Mr. Stanley's from the inventors who are on a still hunt for the best type.

There is probably $800,000,000 invested in electrical work in this country. This immense industry is, in addition, extending into new fields every day.

KIND WORDS.

LEADING ELECTRICAL HOUSES TESTIFY TO THEIR APPRECIATION OF THE "ELECTRICAL REVIEW" AS AN ADVERTISING MEDIUM AND AS AN EXPONENT OF ELECTRICAL SCIENCE.

The ELECTRICAL REVIEW has received a great many letters from the electrical houses of the country. Some of these were in response to an inquiry as to what they thought of the Decennial Number of the ELECTRICAL REVIEW. We think our readers, one and all, will be interested in these communications, as this is something that will not occur again for ten years:

FROM THE MCCREARY ELECTRICAL SPECIALTY CO., NEW YORK.

Accept our hearty congratulations on your tenth anniversary, and thanks for the beautiful and artistic Decennial Number of your excellent journal.

FROM THE ELEKTRON MFG. CO., SPRINGFIELD, MASS.

We wish to congratulate you on that Decennial Number. It is, all in all, the greatest combination of good things that we have ever seen. Electrical progress can, perhaps, be shown in no more striking manner than to compare this with the issues of ten years ago. We hope that the next ten years of the REVIEW will be even more successful.

FROM THE E. P. GLEASON MFG. CO., NEW YORK.

The Decennial Number of your esteemed journal has just come to hand and is in every way an issue of which you may feel proud. We take this opportunity to express our appreciation of the REVIEW as an advertising medium, and to wish you many happy returns of the day.

FROM THE W. S. HILL ELECTRIC CO., BOSTON.

In reply to your letter of the 26th, will say that your birthday gift in the shape of the Decennial Number of the REVIEW was duly received and very much appreciated.

In our extended experience we have never yet had the pleasure of seeing the equal of this edition. From an artistic point of view it is a model, and from a business point of view incomparable.

We trust that the next ten mile post will find you as much in advance as between now and ten years ago.

FROM CHAS. A. SCHIEREN & CO., NEW YORK.

We have received a copy of your Decennial Number, and have read it with very great pleasure. We think it is very nice, indeed, and it does you very great credit.

We wish you abundant prosperity for the next ten years and more.

FROM THE AMERICAN ELECTRIC ELEVATOR CO., NEW YORK.

We are in receipt of your favor of the 26th inst., and also the Decennial Number of the REVIEW. This number is certainly the handsomest journal we have ever seen published.

Your excessive modesty prevents you from praising your own work, but we are glad to adopt the words which you put in our mouth.

FROM THE EVANS FRICTION CONE CO., BOSTON.

Yours of the 26th inst. received, together with your birthday gift to us—Decennial Number of the ELECTRICAL REVIEW—which is found freighted with excellence, and we would say that you have sent us the handsomest issue ever produced in electrical journalism. Modesty in no way prevents us from saying such a thing.

FROM F. P. LITTLE & CO., BUFFALO.

Replying to yours under date of February 26, beg to say that we consider your Decennial Number of the ELECTRICAL REVIEW one of the handsomest issues that we have ever seen. The evident pains which you have taken and the results that you have obtained are a great credit to you, and we feel sure that the electrical people generally, and Buffalonians particularly, cannot help but admire the ability and good judgment shown in getting up this very handsome Decennial Number.

FROM THE SHIPMAN ENGINE CO., BOSTON.

Replying to your esteemed favor of February 26, would say that we take pleasure in stating that your Decennial Number of the REVIEW is one of the handsomest class papers that it has been our pleasure to look through. It is admirably got up in every way and is really a work of art.

We desire to extend to you our congratulations for the first ten years of your existence, and trust that the next ten years will be even more prosperous and satisfactory than the last, and we are confident that you deserve it.

FROM MR. R. B. COREY, OF THE ELECTRIC CONSTRUCTION AND SUPPLY CO., NEW YORK.

I am in receipt of your superb issue of February 20, in which you celebrate your tenth birthday. The Ward arc lamp announcement, which appeared on your third back cover so artistically, testifies to my appreciation of your number. I have endeavored hastily to digest its contents, and have no hesitation in saying that you have done yourselves proud. This is just as good as my saying that you are out of sight of competitors.

FROM MR. GEO. B. SHAW, OF THE NATIONAL ELECTRIC MANUFACTURING CO., EAU CLAIRE, WIS.

One of the most conspicuous illustrations of the marvelous developments during the past 10 years of the uses and applications of that unseen and incomprehensible element, familiarly known as electricity, is the appearance of your Decennial Number of the ELECTRICAL REVIEW.

The book is a work of art, considered from every standpoint; the historical and statistical data are valuable, and the descriptive matter intensely interesting, and it gives me much pleasure to compliment you upon your Decennial publication.

I congratulate you upon the success which you have achieved in the field of electrical journalism, and hope that at the end of another decade you may issue another Decennial Number of the REVIEW, which shall be a veritable cyclopædia of technical information and historical data.

FROM MR. JARVIS B. EDSON, NEW YORK.

I wish to acknowledge receipt of Decennial Number of the ELECTRICAL REVIEW, the perusal of which has caused me much pleasure, owing to its achievement in high class journalism.

FROM THE BALL ENGINE CO., ERIE, PA.

Answering yours of the 26th, in regard to your birthday gift, the Decennial Number of the ELECTRIC REVIEW, would say that we certainly can say that it is one of the handsomest issues we have ever seen, and is a credit to the paper. We wish you continued success.

FROM THE POND ENGINEERING CO., ST. LOUIS, MO.

Permit us to congratulate you on your Decennial Number, just received. It a work of art reflecting the greatest credit on yourselves.

FROM THE FALLS RIVET & MACHINE CO., CUYAHOGA FALLS, OHIO.

Your Decennial Number of the REVIEW is at hand, and after looking it over we desire to compliment you and to say it is one of the handsomest productions in the way of electrical papers that we have ever seen.

FROM MR. W. T. WILSON, OF BICKFORD & FRANCIS BELTING CO., BUFFALO, N. Y.

Your favor of the 26th ult. is at hand and we desire to say that we congratulate you most heartily on your Decennial Number of your paper; it certainly is as handsomely printed and as finely gotten up in every respect as any paper we have ever seen. We were so well pleased with it that we gave your Mr. Richards an advertisement for the coming year. We would like to have it displayed to the best advantage in the space we have contracted for.

FROM MR. RALPH L. SHAINWALD, OF THE STANDARD PAINT CO., NEW YORK.

A copy of your Decennial Number duly reached us, and we regard it as one of the best papers we have seen issued for a long time, and beg to congratulate you upon its completeness. I beg to offer you our sincerest wishes for the continued success of your publication.

The writer might add that he has just returned from a trip to California, and on the train between Ogden and Portland, Oregon, met a gentleman, not at all connected with the electrical industries, but a searcher after knowledge, and found him reading a copy of your paper, in which he was greatly interested. It is evident your paper is pleasing its readers.

FROM THE NEW YORK & OHIO CO., WARREN, OHIO.

We are in receipt of your Decennial Number of the ELECTRICAL REVIEW and must say that it is the handsomest issue ever produced in electrial journalism. We wish to thank you for your gift and hope that the next ten miles will bring even better results than the last.

FROM THE BRUSH ELECTRIC CO., CLEVELAND, OHIO.

Your letter of the 26th is received, also the Decennial Number of the ELECTRICAL REVIEW. We certainly think you have prepared a very handsome issue for your birthday number, and from its appearance we should say that the REVIEW was healthy and in good spirits. We reciprocate your good wishes and hope that you may be blessed with success and prosperity in the future.

FROM THE NOVELTY ELECTRIC CO., PHILADELPHIA, PA.

We have your favor of February 26th, and note contents. We entertain a brotherly feeling for every one who is grubbing for a living in this world, and especially to yourself do we extend the hand of friendship, coupled with our compliments on your success in placing before the electrical fraternity a paper which in point of general get up is worthy of first rank, and an enduring monument to the brains and pluck of its worthy president.

FROM THE EDISON MFG. CO., NEW YORK.

With keen appreciation we acknowledge your birthday gift, the Decennial Number of the ELECTRICAL REVIEW of which it is impossible to say anything too good.

The pace which you have set at the ten mile post is a rapid one, but we are confident that the characteristic energy of the REVIEW will enable it to be surpassed by the time the next landmark is reached

You have our cordial wishes for continued prosperity.

The Invention of the Telegraph.

TO THE EDITOR OF ELECTRICAL REVIEW:

In your recent very attractive special issue, I found an article entitled "The Telegraph in America."

History, to be of real value, must embody no statement other than facts, and, too, not only those of importance, but all having any bearing upon the subject. Now, then, can your contributor reconcile, with a desire to write *real history*, an absolute omission from his article of any mention whatever of the part, in the invention of the electric telegraph, borne by my father, the late Alfred Vail?

It is possible that he may consider my assertion susceptible of modification, for he does mention Alfred Vail as "operator of the Baltimore office!"

I can imagine no other reason than ignorance of the real history of the early days of the telegraph (for which there is no excuse), which could permit him, by this allusion to ignore, yes even *worse* than ignore, the credit due Alfred Vail, who, becoming the partner of Morse, before the patent for the telegraph was applied for, furnished the means to obtain that patent, and, too, to continue the experiments and to send Morse to Washington for the purpose of obtaining an appropriation from Congress by which to construct a line from Washington to Baltimore, to publicly and practically demonstrate the value of the telegraph.

Not only this, but Alfred Vail took Morse to the house of his father, Judge Stephen Vail, at Morristown, N. J., in which he spent the winter of 1837-8, his time being largely spent in painting the portraits of members of the family. During this time Alfred Vail, finding it impossible to reconstruct the crude instrument devised by Morse, and in the construction of which he had exhausted whatever of mechanical ability he possessed, invented the so-called "Morse alphabet" of dots and dashes and the apparatus by which combination resulted the electric telegraph, the same in every respect, except in modification of shape, this day as it was when it came from the brain and hand of Alfred Vail, and *not* those of Morse.

Upon the passage of the bill appropriating $30,000 to build the line from Washington to Baltimore, Morse was appointed superintendent and Alfred Vail assistant superintendent of the government line, and as such were, when the business finished, acting as the "operators."

Morse's means were extremely limited, and it was those furnished by Alfred Vail and his father that produced the telegraph and enabled Morse to go to Washington. On the 3d of March, 1843, the day in the night of which the bill was passed, Morse wrote to Alfred Vail, then in New York, "*If the bill fails to pass to-night, I shall return to New York without a dollar in my pocket.*"

Surely all men, and especially those writing history, should be desirous of giving credit where it is due and it seems to me, if any name at all is worthy of being mentioned as that of the inventor of the electric telegraph, it should be that of him who was the actual inventor.

There is an evident disposition on the part of many who write of the history of the telegraph to ignore the claims of Alfred Vail, but there is a rapidly growing sentiment that the time has come when the claims of Morse as the inventor should be probed, and *I am very curious to ascertain which of the constituent parts—the alphabet, the recording receiver and the key of the telegraph—it can be shown S. F. B. Morse, in the slightest degree, invented, or even participated in the invention of.*

I am yours very truly,

STEPHEN VAIL.

NEW YORK, February 28, 1892.

Well Deserved Thanks.

TO THE EDITOR OF ELECTRICAL REVIEW:

On behalf of the National Electric Light Association, I desire to tender thanks, through the electrical press, to the following named gentlemen for the very efficient services rendered and the numerous courtesies extended to our delegates during the recent Convention in Buffalo:

Mr. M. C. Roach, general eastern passenger agent, N. Y. C. & H. R. R. R., New York city.

Mr. Edson J. Weeks, general agent passenger department, Buffalo, N. Y.

Mr. H. H. Parry, city ticket agent, Buffalo, N. Y.

Mr. J. C. Yager, division superintendent, Wagner Palace Car Company, New York.

Yours very truly,

C. O. BAKER, Jr.,
Master of Transportation.

New York, Mar. 1, 1892.

FRIENDLY LETTERS.

WELL KNOWN ELECTRICAL GENTLEMEN PAUSE A MOMENT TO WRITE A WORD OF CONGRATULATION AND COMMENDATION.

FROM PROF. ELIHU THOMSON.

TO THE EDITOR OF ELECTRICAL REVIEW:

I have examined with interest the Decennial Number of the ELECTRICAL REVIEW. You are certainly to be congratulated on this issue. It represents a good deal of life and energy on your part, and is a decided success.

Yours very truly.

ELIHU THOMSON.

Lynn, Mass., Mar. 1, 1892.

FROM MR. FRANK B. KNIGHT.

TO THE EDITOR OF ELECTRICAL REVIEW:

The Decennial Number of the REVIEW is at hand, and I cannot let the occasion pass without telling you how beautiful I think it, and how deserving of all praise and generous support are the publishers of a journal who can, and do, supply their patrons with such a rich treat. From the appearance of the advertising pages you seem to be getting the support all right enough. Success to you! Very truly yours,

FRANK B. KNIGHT.

Austin, Texas, Feb. 26, 1892.

FROM GEN. E. S. GREELEY.

TO THE EDITOR OF ELECTRICAL REVIEW:

I have received with much pleasure the Decennial Number of the ELECTRICAL REVIEW. Please accept my congratulations and best wishes for the success that ought and must follow your enterprise and energy. The REVIEW has already won for itself an enviable position in the electrical newspaper field. The REVIEW is a splendid paper—may it receive the reward to which it is entitled.

E. S. GREELEY.

New York, Feb. 29, 1892.

FROM MR. C. S. VAN NUIS.

TO THE EDITOR OF ELECTRICAL REVIEW:

It was not from lack of admiration of the taste displayed in the birthday attire of your ten-year-old journal that I have not extended my congratulations earlier, and at this late day I beg leave to say that the best parlor of the leading hotel of Buffalo was none too good for so regal a visitor at the recent electric light convention.

May the beauty and influence of this charming young princess increase and widen, until, at "sweet sixteen," admiring thousands shall proclaim her a queen, in grandeur and power, among electrical journals. Respectfully yours,

C. S. VAN NUIS.

New York, March 4, 1892.

FROM MR. N. T. PULSIFER.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—I have been meaning to write you for the last three or four days to congratulate you on the very beautiful issue of the REVIEW as brought out by you in its Decennial Number. This number appealed to me, as a paper maker, as much as it did in connection with electrical matters. The quality of the paper used and the typographical skill displayed in getting out this number is certainly a subject of congratulation. Yours truly,

N. T. PULSIFER.

Manchester, Conn., March 4, 1892.

FROM MR. GEORGE CUTTER.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—Your Decennial Number, in its dimensions, its variety of reading matter and its hints at a still grander future, may well be taken as a type of the electrical progress of ten years. I trust that during the next decade you will maintain that cheerful tone and that insight into electrical needs which has made your paper what it is.

Yours truly,

GEORGE CUTTER.

Chicago, Ill., March 2, 1892.

FROM MR. D. H. LOUDERBACK.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—Your Decennial Number of the REVIEW is one of the handsomest publications I ever saw, and would do credit to the largest publishing house in the country. Your illustrations were particularly good.

I am glad to see so much enterprise shown in your field of journalism. You are keeping up with the procession at all points.

Yours fraternally,

D. H. LOUDERBACK.

Chicago, Ill., March 3, 1892.

Telephonic News

*** The Pacific Telephone and Telegraph Company has just issued a new and very convenient telephone directory.

*** A bill was recently introduced in the Iowa Senate proposing to tax each telephone and telegraph instrument, also for each pole within city limits.

*** The Belt Line trains at Chattanooga, Tenn., will hereafter be regulated in their movements by telephone, instead of by telegraph, as formerly.

*** It is the desire of the New England Telephone Company to place all its wires underground in Lowell, Mass., and permission has been asked to authorize it.

*** The Telephone Subscribers' Association, of New York, which is agitating for lower rates, favor the appointment of telephone commissioners in cities of the State having 60,000 or more inhabitants.

*** The Bell telephone output for the month ending February 20, was as follows:

	1892.	1891.	Inc.
Gross output.....	7,931	6,072	1,859
Returned.....	5,070	3,276	1,794
Net..	2,861	2,796	65
From Dec. 20, 1891, to Feb. 20, 1892:			
Gross.....	13,564	10,237	3,327
Returned.....	9,306	6,394	2,912
Net.....	4,258	3,843	415

*** At the recent annual meeting of the Hudson River Telephone and Telegraph Company, the following gentlemen were elected directors: Jos. P. Davis, New York; Col. D. B. Parker, New York; A. B. Uline, Albany; H. L. Storke, Auburn; Jas. Bigler, Newburgh; C. J. French, John E. Hudson, Boston; James H. Manning and D. Cady Herrick, Albany. The following officers were elected for the ensuing year: President, Jos. P. Davis; vice president and general manager, A. B. Uline; secretary and treasurer, H. L. Storke.

The Brush Lamp Wins Again.

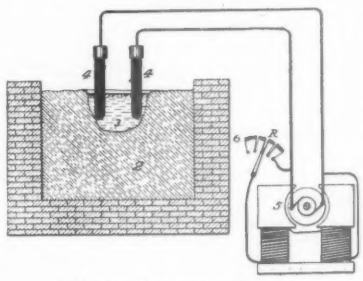
Judge Shipman, of New York city, handed down a decree on March 1, in the suit of the Brush Electric Company against the United States Electric Lighting Company, for an injunction restraining them from using a double carbon arc lamp. Judge Shipman finds that the lamp in question was patented by Charles F. Brush on September 2, 1879, and that patent is now owned by the Brush Company. He, therefore, grants that company a perpetual injunction against the United States Company, and orders that testimony be taken as to the amount due the Brush Company for the infringement of their patent. Judge Shipman issued an order to compel the agents and directors of the United States Company to testify as to their profits during the years that they used the Brush lamp.

Queen & Company.

Since acquiring the American patents which control the Cardew voltmeter, Queen & Company have made extensive preparations to manufacture this celebrated instrument. Special tools have been procured so that the mechanical parts may be constructed in the best manner possible, and in the new Queen laboratory every facility is afforded for exact calibration. The Cardew has an enviable name as a standard voltmeter, for it possesses qualities not to be found in any one other instrument. It is dead beat, direct reading for both alternating and continuous currents, contains no permanent magnets nor parts liable to change, can be left constantly in circuit, and the indications are correct within one per cent. under all circumstances. These qualifications render the Cardew one of the best station voltmeters on the market, and a satisfactory potential indicator for marine installations. Queen & Company inform us that they are making these instruments in large quantities to supply the increasing demand.

Broad Aluminum Patent.

A broad patent for reducing metals from their ores or compounds by electricity has been recently issued to Charles S. Bradley, which will, doubtless, cut an important figure in the aluminum industry. The application for this patent was filed early in 1888, prior to which time the process of aluminium reduction was carried on by subjecting the fused ore to the action of an electrolyzing current of electricity while contained in a crucible or other refractory vessel placed in a heating furnace having a temperature sufficiently high to melt the ore. Great difficulty was encountered in preventing the destruction of the crucible on account of the action of the fused ore upon its walls. Especially was this true in the case of cryolite, a double fluoride of aluminium and sodium, which exerted a fluxing action on the crucible. The essential feature of Mr. Bradley's process consists in fusing the refractory ore, whether of aluminum or of



A Broad Aluminum Patent.

any other metal, by a source of heat furnished by the current itself. Two electrodes of carbon are inserted in a mass or pile of the ore, and a current of a greater strength than required for electrolysis alone is applied to the electrodes. The current fuses the ore by the heat developed, after which electrolysis takes place. The current thus performs two functions, one being to melt the ore and the other to reduce the metal therefrom. A crucible is entirely dispensed with. The electrodes, upon starting the operation, are brought into contact and then separated a slight distance to spring an electric arc, and then thrust into the mass of the ore, some of which is instantly fused by the heat of the ore and becomes a conducting electrolyte, through which the process of fusion and reduction is continuously maintained. The arc ceases to exist as soon as the ore between the electrodes is fused. In view of the fact that the current itself is used to maintain the ore in fusion, it is made of greater intensity than currents used for electrolyzing an ore fused by the furnace process. A diagram of the apparatus is illustrated in the accompanying engraving, which is self-explanatory. The following claims show the scope of the patent:

1. The process of separating or dissociating metals from their highly refractory ores or compounds, non-conductors in an unfused state, of which the ores and compounds of aluminum are a type, which consists in fusing the refractory ore or compound progressively by a source of heat concentrated directly upon it, rather than by an external furnace, and as it becomes fused effecting electrolysis by passing an electric current therethrough between terminals, which are maintained in circuit with the fused bath whereby the process is rendered continuous, substantially as set forth.

2. The continuous process of separating or dissociating metals from aluminous or like refractory ores or compounds, non-conductors in an unfused state, which consists in progressively fusing the refractory ore or compound, and as it becomes fused electrolyzing it by passing an electric current therethrough of sufficient volume to continue and maintain the fusion and effect electrolysis, and adding fresh material from time to time to preserve the bath constant, as set forth.

3. The process of reducing metals from that class of highly refractory ores and compounds, non-conductors in an infused state, of which the ores and compounds of aluminium are a type, which consists in fusing a portion of the refractory ore or compound to be treated, in establishing an electric current through said fused portion, and by such current producing simultaneously progressive fusion of such ore or compound and continuous electrolysis of the same as fused.

4. The process of separating or dissociating aluminum from its ores or compounds, consisting in fusing and maintaining the fusion and electrolytically decomposing the ore or compound by the passage of the electric current therethrough, substantially as set forth.

5. The continuous process of separating or dissociating aluminum from its ores or compounds, consisting in fusing and maintaining the fusion and electrolytically decomposing the ore or compound by the passage of the electric current therethrough and charging the bath with fresh quantities of the ore or compound as the reduction proceeds, substantially as set forth.

6. The process of separating or dissociating aluminum from its ores or compounds, consisting in fusing and maintaining the fusion and electrolytically decomposing the ore or compound by the passage of the electric current therethrough and regulating the strength of said current in accordance with the requirements of the fused mass, substantially as set forth.

Edison Ceiling Cut-Outs.

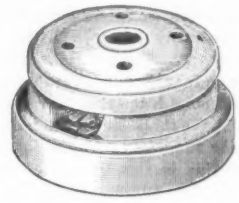
The growth of practical electrical application and its adaptation to popular use has created an immense demand for cheap appliances which are required to be at the same time thoroughly efficient in their functions. As a consequence, there has been called into existence a large number of these appliances which, however, have not, in every case, realized the high hopes based on the pretensions set forth by the manufacturers. Among these appliances, ceiling cut-outs are not the least numerous. Recognizing the possibility of the increase in demand, the Edison General Electric Company invented and patented, some years ago, a ceiling cut-out embodying most of the fundamental principles underlying all cut-outs devised for a similar purpose. Recently, the old form of single pole pendant cut-out was superseded by a double pole cut-out of a novel shape, especially devised for cleat work, and

Edison Cut-Out, No. 1023.

possessing additional recommendations and advantages.

In the manufacture of this, the Edison Company, fully cognizant of the important factor of cheapness, succeeded in so reducing the cost by the adoption of new principles of manufacture that it could be sold as cheaply as the cheapest ceiling cut-out in the market without depreciation of quality. This was followed shortly afterward by two new double pole cut-outs, one for moulded work, the other for concealed work. These are of special design and of superior workmanship to that mentioned above, their interior construction, however, being similar. The contact pieces in the porcelain base are flat and are provided at their terminals with small indentations which serve to catch and retain the bent contact pieces in the cover and make a perfect contact. Two safety fuses protect the appliance. The cut-outs are made of the best hard, white, non-absorbative porcelain.

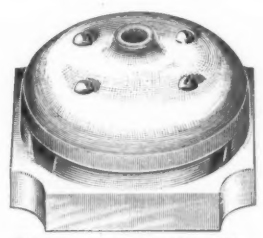
The two last named cut-outs lend themselves with peculiar facility to decoration; and when decorated, form a valuable adjunct to the available stock of the present day interior decorator. The Edison Company will shortly be ready to supply decorated ceiling cut-outs to suit any or all requirements. The designs already selected are varied and artistic. The establishment of a porcelain factory under their immediate supervision, in their own works at Schenectady, has enabled them to bring these cut-outs to that high



Edison Cut-Out, No. 123.

state of perfection already attained by manufacturers of the most advanced porcelain for electrical purposes in England, where the development of porcelain for electrical uses has heretofore been greatest.

The use of ceiling pendant cut-outs has hitherto been confined to lights hung from the cut-out by a flexible twin conductor. The flattened shape of the No. 123 cut-out permits of its use with a swinging light hung from it by a length of metal tubing. To effect this end, the cover of the appliance is provided with an universal joint, to which is attached the tube. The light can be swung to a considerable distance from its normal point of rest, returning thereto much more

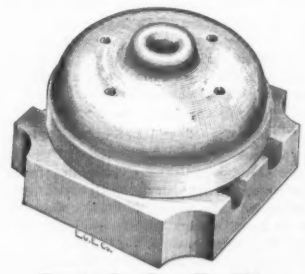


Edison Cut-Out, No. 696.

quickly than is the case with the flexible cord pendant. The main advantages for store lighting and similar work presented by this arrangement are obvious.

The Record Beaten.

The mining town of Creede, Colo., the mushroom town of the West, has, among other remarkable things, the distinction of having had an electric light plant consisting of two 100 horse-power boilers, an Armington & Sims 100 horse-power engine, a 30 light arc dynamo, a 400 light incandescent dynamo and two 50 foot iron smokestacks, installed in its midst in about three days. The actual time occupied in erecting the plant was from February 3, 7 A. M., to February 6, 11.15 P. M., with an allowance of possibly six hours a day for sleep. The idea of placing the plant in Creede was conceived by John N. Flentham, general manager of the Denver Consolidated Electric Light Company, on February 1. The project was soon approved in council, and the Creede Electric Light and Power Company



Edison Cut-Out, No. 396.

was organized. The machinery, poles, wires, etc., were gotten on board a special train of five freight cars and shipped to their destination without a moment's loss or one hitch. The necessity for this haste was to forestall any rivals in the field. It was a rapid piece of work, and reflects credit on those who planned, as well as those who carried out, the details of the work.

The Delany Crowfoot Zinc.

The E. S. Greeley & Company have become the sole licensees for the manufacture and sale of the new zinc shown in this cut, the invention of Mr. P. B. Delany. The zinc itself is just like the ordinary crowfoot zinc in common use, but Mr. Delany has added a very simple and effective means for the removal of the stalactite formations of spongy copper which form on the under side and hang down into the copper solution,

THE DELANY CROWFOOT ZINC.

thus setting up local action and causing great waste of zinc and bluestone.

The device scarcely needs description. A glance at the cut will show a wire sweep through the central toe of the zinc. The wire is bent on a horizontal plane with the zinc, so that by touching the eye-end projecting above the solution the sweep is free to move in either direction so as to thoroughly sweep or brush the entire bottom of the zinc from center to circumference, thereby sending all the spongy coating to the bottom of the jar. Heretofore this operation has been attended with so much difficulty that it was either imperfectly done or neglected altogether.

The careful battery man or operator who has angled in a gravity cell with a piece of bent wire, smutching his fingers and twisting his neck for a minute or more trying to dislodge an inaccessible pendant, will welcome this simple improvement which will enable him to clean off a thousand zincs in a few minutes without splashing the shelves

A NEW CEILING PENDANT CUT-OUT.

or his best suit of clothes. With this improvement it will not be necessary to disturb zincs from the time they are placed in the battery until entirely used up.

Beside the great saving effected in zinc and copper, the resistance and efficiency of all the cells of a battery will be uniform, as the laziest or most careless attendant will not fail to give the sweep an occasional twist.

As we understand that the nature of the device is such as to add little or nothing to the cost of the zinc, we see no reason why the Delany form of crowfoot zinc should not be in great demand.

One by one the standard articles in use are approaching perfection. This simple improvement will again raise the usual question, "Why was it not thought of before?"

The Knapp Motor.

The Knapp Electric and Novelty Company, 34 Warren Street, New York, have recently put upon the market the little motor illustrated herewith. It is self-starting, six inches high and weighs about four pounds. The motor is mounted on a mahogany base, but the binding posts are placed on the iron work of the machine so that it may be fastened to a table or any convenient place desired.

This motor is carefully made and is finished in enamel with brass trimmings. It is designed to operate six to ten inch fans, toys and light machinery. A six inch fan is sent with each motor.

A New Ceiling Pendant Cut-Out.

Another new form of ceiling cut-out has recently been added to the long list of special and improved devices now upon the market. The block illustrated herewith is a development of a design by Mr. J. Van Vleck, electrician for the Edison Electric Illuminating Company, of New York, for whose special requirements it was originally made.

Mr. Van Vleck has succeeded in embodying in one block of small dimensions all the desirable features that such an appliance should possess.

The cut-out is adapted to both exposed and surface work; in the latter case the wires are brought directly through the base to the binding posts and do not appear on the outside of the cut-out. It has a square base and, consequently, is especially adapted to moulding work.

The interlocking contacts are substantially made, and of such a character as to permit of no loose connections or the liability of the same working loose. Double pole safety catches are concealed in the cover, permitting easy renewal without disturbing the base of the block, and the room for making connections is not cramped.

Possessing no external binding posts or metal parts, the block has found favor and received the endorsement of the Fire Underwriters.

The block is known as the V. V. ceiling cut-out, and a close inspection or trial will readily demonstrate that the claim of the manufacturers, the Interior Conduit and Insulation Company, that it is the neatest and best, is well founded. It is sure to meet with the approval of those who demand the best.

The Wenstrom Company.

In the City Circuit Court of Baltimore, Md., recently, Jacob H. Stadelman, assignee, by Barton & Wilmer and William Reynolds, their attorneys, filed a petition against the Wenstrom Consolidated Dynamo and Motor Company and others, praying the court to pass an order requiring the receivers of the company to make an assessment upon the stockholders of the so-called treasury stock of the company for so much of the amount of the par value of the stock held by them as may be still unpaid to the corporation, and as may be sufficient, together with the assets in their hands, to pay in full all the indebtedness of the incorporation. The court is also asked to empower the receivers to institute suits in law or at equity against the stockholders for the due enforcement of their statutory liability to the creditors of the corporation. Judge Phelps signed an order requiring the defendants to show cause, on or before March 10, why the order should not pass as prayed.

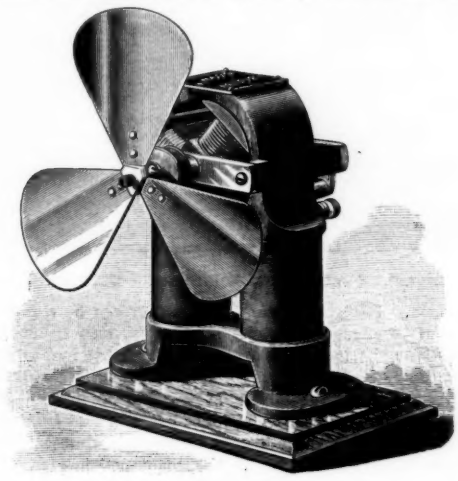
The Wood Arc Cut-Out Box.

The accompanying illustrations show the new arc cut-out box which has been recently adopted by the Thomson-Houston Electric Company as superior, in their opinion, to any yet placed upon the market. The switch is expected to displace the older and more complicated forms previously used, being simpler in construction, neater in appearance and having fewer wearing parts.

The action is instantaneous and automatic, with no possibility of a stop between "make" and "break," and is an absolute cut-out on both sides of the branch line to which it is attached. The switch is enclosed in an iron box—Fig. 1—cast in one piece, making it perfectly waterproof. It is fitted with an iron cover containing a square slot, through which is seen an enamel tell-tale plate, clearly showing whether the current is on or off.

Fig. 2 shows the mechanical arrangement in detail. The handle being pulled downward, the pressure of a spring forces apart two rollers which in turn press outward two lever arms, breaking the circuit at two places simultaneously.

This switch is absolutely fireproof and perfectly insulated, the switch parts being mounted on a slate base, which is securely fastened within the iron frame.



THE KNAPP MOTOR.

FIG. 1.—WOOD CUT-OUT.

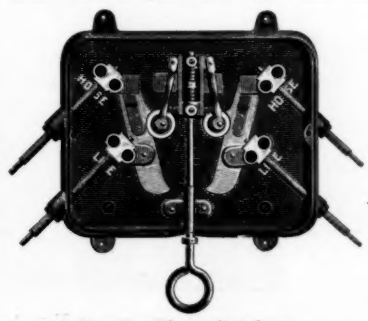


FIG. 2.—WOOD CUT-OUT.

The Siemens & Halske Electric Company, Chicago.

The Siemens & Halske Electric Company, of Chicago, which was recently incorporated, elected officers and directors on March 3. They are: O. W. Meysenberg, president; A. W. Wright, secretary; and Arnold von Siemens, George William von Siemens, O. W. Meysenberg, A. W. Wright, and Alexander von Babo, directors. The plan of the company, it is said, is to spend $500,000 in the construction of a temporary plant which will be operated in connection with that of the Wells & French Company, of which Mr. Meysenberg is president. In the construction of the permanent plant, it is said, from $3,000,000 to $5,000,000 will be invested. Eventually it is expected to make this plant larger than any of those now operated in Europe. The new company will have the advantage of the $40,000,000 capital of its projectors, and, with the large number of valuable patents and applications for patents which it now has in the United States, its promoters say, will be able to make itself a competitor of the combined Edison and Thomson-Houston companies.

TELEGRAPHIC

.... A submarine cable to connect Cuba and some point in Yucatan is to be laid soon.

.... The Western Union is preparing to build a telegraph line from Seattle to Wooley, to tap Anacortes, Wash.

.... The seventh annual ball of the Telegraphers' Mutual Aid Association, of Boston, took place on the 27th ult., and was a brilliant success.

.... The Commercial Union Telegraph Company will extend their lines to Keene, N. H., running a loop to Hinsdale, thence through Ashuelot and Winchester.

.... Thomas Dolan, for 15 years night manager in the New York office of the Western Union Telegraph Company, died recently, of apoplexy. He was one of the oldest telegraphers in the United States.

... For some time there has been trouble in the New York Produce Exchange about the private wires between here and Chicago leased by some of the brokers, and there has been talk of disallowing their use. The board of managers last week decided to permit the brokers to renew their contracts for the wires for another year.

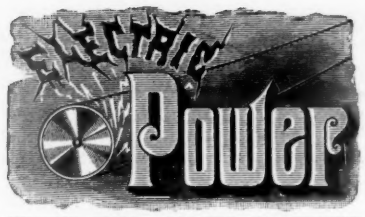
.... A. B. Chandler, president of the Postal Telegraph Cable Company, and son (A. E. Chandler) and G. G. Ward, general manager of the Mackay-Bennett Commercial Cable Company, are South on a tour of inspection of the principal offices of the Postal Telegraph Cable Company in the South Atlantic and Gulf States.

.... Judge Ingraham, of New York, has granted an injunction restraining the Western Union Telegraph Company from paying royalty on the leased lines of the Montreal Telegraph Company. The Montreal Telegraph Company leased its lines to the Great Northwestern Telegraph Company, of Canada, for 10 years. The consideration was eight per cent. on the capital stock of $2,000,000, or $160,000. The Western Union Company guaranteed the payment of the royalty, and, as the Canadian company has not paid, the Western Union has been compelled to hand over $160,000 a year. The argument on making the injunction permanent will be heard March 4. The two Canadian companies and the Western Union will oppose the motion, the latter because it means to stand by the contract with the Canadian companies.

LITERARY.

"Transactions of the American Institute of Electrical Engineers," for January, 1892, contains Mr. Charles Proteus Steinmetz's address "On The Law of Hysteresis," which has already been published in the ELECTRICAL REVIEW. An index to Vol. VIII, of the "Transactions" and a remarkably good steel engraving of Professor Thomson are sent with this number.

When the attempt was made to give twice as many illustrations in a monthly magazine as were ever before published, the "know it all" people said, "it won't last;" but when the *Cosmopolitan* went even beyond that figure and continued to thrive and grow more popular, the fact became apparent that not only could it be done, but that the reading public appreciated it. So far the success of this brilliant magazine has never been equalled in the history of illustrated monthly literature, and it is daily finding its way into new homes throughout the country. The latest master stroke, in obtaining the services of William Dean Howells as associate editor, is the talk of the literary world. To make the magazine still more popular, its publishers are offering, for almost nothing, a choice of the original editions of the memoirs of Generals Grant, Sheridan, Sherman, McClellan and Lee, if taken in connection with a year's subscription to the *Cosmopolitan Magazine*. If you are not on reading terms with this popular monthly, write to the Cosmopolitan Publishing Company, Madison Square, N. Y., for a free sample copy; then judge for yourself.



* * The Concord, N. H., Street Railway Company are experimenting with heating cars by electricity.

* * The Leavenworth and Suburban Street Railway Company, of Leavenworth, Kan., is talking of using electricity as motive power.

* * A syndicate, of which J. & W. Seligman are the representatives, have purchased all the surface roads of Cleveland, O., for $9,000,000.

* * Marshall, Mich., is negotiating for a water power for the purpose of using it to supply electric light to the city and power for manufacturing purposes.

* * A quarterly dividend of two per cent. will be paid on Northwest Thomson-Houston electric preferred stock March 15, 1892, to stockholders of record March 5.

* * The capital of H. Ward Leonard & Company has recently been doubled and the increase taken by gentlemen prominent in the leading railway, banking and gas interests of New York City.

* * The Berkshire Electric Company, of Pomona, Cal., recently commenced putting up wires and apparatus for electric lights in that city, the dynamos to be run by water power 13 miles distant.

* * There is a project on foot to establish a big electric light, heat and power plant at Palatine Church, to supply St. Johnsville, Fort Plain, Nelliston, Palatine Bridge and Canajoharie. Water power will be used.

* * Maine is to have an actual electric railroad to run between Rockland and Camden, a distance of 9½ miles. The road is to carry passengers, freight and mail. The freight cars will be closed as on any other railroad. It is expected, at no distant date, to have the road run to Thomaston, also. Work on construction will be commenced as soon as the weather permits and it is expected to have the road in operation by June 1.

A Model Mine Equipment.

The utilization of sources of power remote from points of application has, during the past two years, received considerable attention from electricians in this and other countries, and repeated experiments have demonstrated the practicability of utilizing power, by the adoption of electrical methods, which would otherwise be wasted, and of its utilization to such advantage that projects may be, and have been, carried out which, without the application of electricity, would have been impossible. This has been particularly the case in the mining industry. Lodes of metal are frequently found at great altitudes, where, unless some cheap power can be applied at the required spot, they can never repay working. It is not so long ago that a project to generate power for mining purposes at the foot of a mountain and utilize it economically midway, or at the summit, would have been scoffed at as visionary; but this feat has been accomplished and with complete success.

Probably the best example of this, at the present time, is the large plant which has been installed by the Edison General Electric Company, at the Virginius group of mines near Ouray, Colo. It is one of the largest, if not the largest, purely mining plant in the world. Every difficulty likely to be met with in work of this nature was encountered in the installation. The pipe line is laid along the side of a rocky canon; the wires from the power house to the mine are strung partly through dense timber, where they are exposed to damage from falling trees, and partly above timber line, over rocks and snow banks, where the poles and wires are liable to be carried away by snow-slides and where lightning storms are frequent and violent. The line is nearly four miles long, the voltage of the current 800 volts, and the mine is wet. The relative advantages of the ground return and complete metallic circuit are illustrated, and switches are so arranged that either may be employed, the metallic circuit being used at present. The plant includes a variety of machinery, comprising two pumps, one hoist, one blower, and two motors running mills; indeed, almost everything, except locomotives and drills, and these will probably be added shortly. Lastly the enormous saving that can be effected in many places by the utilization and transmission of water-power by means of electricity, is strikingly manifested. Coal at the mines costs $18 per ton, and before the installation of this plant was made the cost of the power amounted to nearly $40,000 per annum. This sum is saved by the adoption of electric power. An instance is also afforded of unprofitable mines being rendered profitable by the use of cheaper power, for, while some of the mines in this group are rich enough in metal to repay working under the most adverse conditions, there are others of lower grade which would have been shut down in case the electric plant had proved a failure, but which, with the plant, will now yield a satisfactory profit.

FIG. 1.—MODEL MINE EQUIPMENT.—ELECTRIC POWER HOUSE, 9,000 FEET ABOVE THE SEA.

The Virginius and neighboring mines, owned by the Carolina Mining Company, are situated near the summit of Mount Sneffles, in the region of perpetual snow, at an altitude of 12,700 feet above the sea, and about 5,000 feet higher than timber line. They are reached by a wagon road, open in the summer, but impassable in the winter, when the only route to the mines is by a difficult trail, the lower part of which, denominated the "zig-zag," winds up a declivity so precipitous that burros with their packs slipping from the trail frequently roll down past several branches of the zig-zag before they are stopped by a tree or rock. The upper part extends over a rocky plateau above timber line, and along cliffs where the snow is frequently over 20 feet deep on the level, and where terrific wind and lightning storms are frequent. The lower half of the line, from the power house to the foot of the zig-zag, extends up a deep canon through a forest of dense timber. The danger of breakage and grounds from falling trees, which are frequently blown down by storms and rest on the wires for some time before they can be removed, is continually present. The construction of heavy line work over nearly four miles of such ground is an undertaking, the difficulty of which is evident, but which can be fully appreciated only by an actual examination; while the maintenance and operation of the plant under the conditions just specified present even more serious difficulties. But, although these difficulties are exceptionally great, the enormous expense of transporting fuel to the mines rendered the advantages of an electric transmission plant so very striking, that the management was induced to make the trial.

The water power utilized for the plant is in Red Canon Creek, nearly four miles from the mines. The water power plant consists of a small dam, an iron pipe line extending along the side of the canon a distance of about 4,000 feet, giving an effective head of 485 feet, and two Pelton wheels, one five feet, the other six feet in diameter, capable of developing under that head 500 horse-power and 720 horse-power, respectively, or a total of 1,220 horse-power, the two wheels being connected to separate shafts, so that either wheel may run the entire station. The electric generating plant comprises at present, one 100 kilowatt Edison dynamo and two 60 kilowatt Edison dynamos, giving a total output of 293 electric horse-power. The length of the line, as previously described, is a little over 19,000 feet. The electric machinery operated at the mines consists at present of two pumps, 60 horse-power and 25 horse-power, respectively; one hoist (25 horse-power), two Edison motors, each of 60 horse-power, running concentrators and stamping mills and 15 horse-power blower. The large pump, which was erected when the plant was first installed, raises 150 gallons of water, 700 feet per minute, and is of the Knowles duplex type. An Edison standard motor is geared to it by a double worm, one right hand and one left hand, working into two spur-gears that mesh into each other and operate the pump, the object of the two worms being to neutralize the longitudinal thrust. The smaller pump, which was installed a few months ago, is somewhat similar, the motor, however, being mounted over the pump, with its armature vertical, the weight of the armature counteracting the thrust of the single worm employed. Both pumps have been working steadily and smoothly for several months, and have satisfactorily filled requirements.

The hoist consists of an Edison motor of standard type, but of street car winding, and controlling switch, geared to the drum through the medium of a friction clutch. By means of the controlling switch and clutch, the hoist is under more perfect control than a steam hoist.

The motors for the mills and blowers are of the standard type, and present no exceptional features.

The most serious troubles have been caused by lightning—electric storms in that section of the country being frequent and very violent. This has formed the subject matter of particular study, and special lightning arresters have been devised that give excellent protection. Since their adoption little or no trouble has been experienced from this source.

That difficulties were encountered in the early operation of the plant is not surprising, and the fact that these difficulties have been overcome and the entire plant is operated successfully and satisfactorily under conditions that for severity are not likely to be exceeded anywhere, demonstrates the practicability of electric power for mining, and guarantees its success in this field.

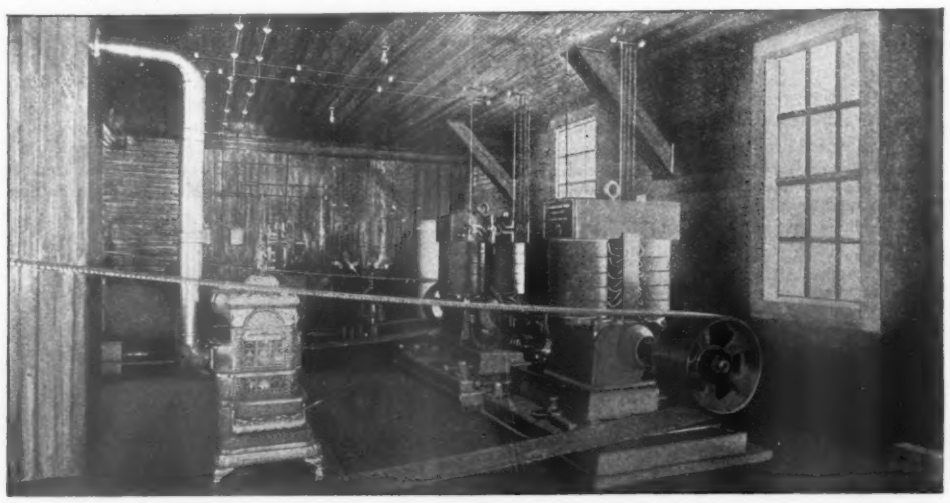


FIG. 2.—INTERIOR OF POWER HOUSE.—EDISON EQUIPMENT.

PROF. THOMSON'S LATEST WORK.

AN ARC AIR BLAST FOR RAISING THE FREQUENCY OF ALTERNATING CURRENTS.

The literature of electricity has been further enriched by the publication of a series of beautiful experiments made by Prof. Elihu Thomson with high tension currents in which electrostatic discharges were electro-dynamically converted into oscillations having an extraordinary frequency and a potential of probably hundreds of thousands of volts. The results of his researches are intensely interesting, not only from a scientific point of view, but as inspiring the conviction that a revolution in the method of electric lighting is dawning. The classical experiments of Tesla with high tension currents of short period are familiar to readers of the ELECTRICAL REVIEW. Mr. Tesla generated electro-magnetically alternating currents of short period, realizing by a generator specially constructed for the purpose as many as 20,000 reversals per second. It is believed by electricians that if current waves of sufficiently short period could be generated light would be developed by what is supposed to be molecular bombardment, which would give out in luminous waves 100 per cent. of the energy consumed, thus yielding an absolutely perfect conversion and rivaling the process of nature at work in the humble but mysterious firefly. Professor Thomson's investigation in this line is the outgrowth of his work upon a lightning arrester for which letters patent were recently issued and which was described in the REVIEW for July 11, 1891, page 263. For the information of those who may not remember that interesting invention, we present in Fig. 1 a diagram illustrating the device, which comprises two coils reversely wound and placed one within the other. The coils are highly insulated from each other, one preferably being wound within and the other without a glass tube. One terminal of each coil is connected to line, the other terminals passing both to earth E through lightning arrester A in shunt relation to which is the dynamo to be protected; or one coil may pass through the lightning arrester and the other through the dynamo. If, now, a lightning discharge should strike the line L such discharge, in passing to earth

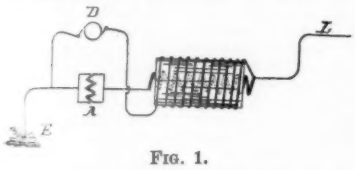


FIG. 1.

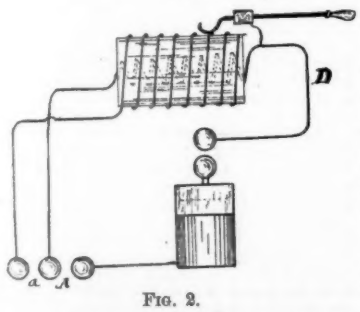


FIG. 2.

through one coil, will induce a discharge in a reverse direction in the other coil. The coil in the dynamo circuit is given more turns than the other so that the counter electromotive force generated by the discharge is relatively greater in this coil and the discharge, selecting the path of least inductive resistance, will flow to earth through the saw-teeth arrester plates A. In endeavoring to ascertain the best relations of the coils a Toepler-Holtz static induction machine was called into service by which a Leyden jar was kept continuously charged. The coils being arranged as shown in Fig. 2, that is to say, a wire L leading from a junction of one set of coil terminals to a knob separated by a short spark gap from the knob of the jar and the other coil terminals connected to knobs separated by a small air gap from each other and from a knob connected by a conductor to the outer coating of the Leyden jar. When disruptive discharge occurred between the jar knob and the knob connected with wire L it simulated a condition of a line as L when struck by lightning. A sliding contact was used over the outer coil so that the relative counter electromotive forces of the two coils might be varied. It was found when a certain length of the outer coil was employed a slight, almost imperceptible spark appeared at *a*, but if this balance was disturbed by sliding the contact, not only did a vigorous spark occur at *a* but the gap could be considerably extended, increasing as the inequality of the two coils increased, thus indicating that when a balance is established, a selective path may be provided for the Leyden jar discharge thus insuring in the condition exemplified in Fig. 1 absolute protection for the dynamo. It was also noted that when a disturbance in the balance of the coils was made resulting in a spark at *a*, this spark was of a different character from that of a Leyden jar discharge. It was less luminous, less sharp in sound, and is believed to be partially due to a current local to the coils in series with one another. Another curious effect was noticed when the knobs were arranged as shown in Fig. 3 T and Y shaped discharges being developed, as indicated in the detached views of the diagram. In this experiment the knobs at A were separated 1½ inches, the discharge appearing to split and unite in the air. These effects led to the conclusion that a discharge passed through a coarse wire primary coil might be made to produce a current of much higher potential in a co-operating coil of finer wire and greater number of turns. If, for example, in lieu of a battery current discharging through a primary of a Ruhmkorff coil a Leyden jar be made to discharge through the coil the secondary might be expected to develepe a much intensified electromotive force. An experiment was then made with a coarse coil of ten turns in a a glass tube without any iron core and a fine coil of 120 turns on the outside of the glass tube and it was found upon discharging the Leyden jar through the coarse coil that sparks could be obtained from a single turn in the secondary coil and a spark of greatly increased length from the whole of secondary coil. It was found that although immersed in oil, glass tubes one-eighth inch thick were frequently punctured. A modification of the apparatus was made by which sparks seven or eight inches in length were obtained making a loud, roaring sound and limited in length only by the ability of the secondary coil to maintain the insulation. The organization of apparatus is illustrated in Fig. 4 wherein A represents a transformer capable of using in its primary ordinary alternating currents of 50 or 100 volts and transforming up to 10,000 or 12,000, by which a spark from one-half to one inch might be obtained between its terminals. An adjustable condenser B was connected across the terminals and a blast of air directed upon the arc at J, changing it into a beautiful pale, purple flame, filled with fine and thick shreds forming a network of electric fire, changing with any change of direction of the air blast. The current from this secondary was carried through a coarse coil of 15 or 20 turns within a glass tube, around which was wound a single layer of 150 turns. The tube and its coils were immersed in heavy oil as shown at C. The terminals of secondary were connected to adjustable discharge rods as shown at D. With this apparatus the one-fourth sparks at J, are accompanied by a torrent of sparks seven or eight inches in length at D. In attempting to increase the length of sparks beyond this limit, sparks could be seen jumping from the primary to the secondary in the oil. If the coil C were not well submerged in the oil, the sparks would break through the oil and pass over its surface creating great agitation. If arranged, for example, as in Figs. 5 and 6, where two disks are connected to the secondary terminals and brought near the top surface of the oil, the oil will be punctured and scattered and violently disturbed, while a shower of sparks will pass over its surface between the disks. Geissler tubes placed in the vicinity of the jar containing the oil are lighted. The alternating current used had a frequency of 125 or 250 alternations per second. Professor Thomson observes that these experiments provide a means of studying the potential and rate of oscillation of lightning discharges. The blast of air had a marked effect upon the intensity of the discharge. For example, if in Fig. 7, C represents a transformer, such as described in

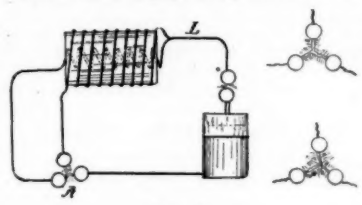


FIG. 3.

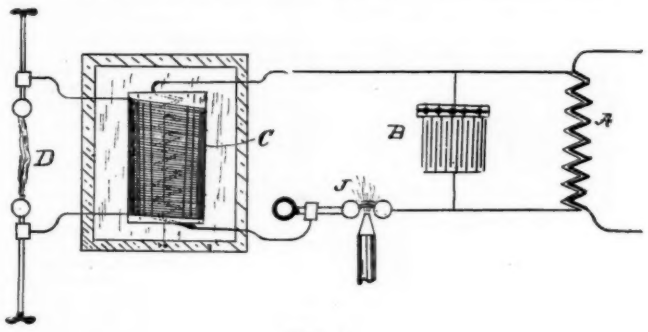


FIG. 4.

Fig. 4, capable of raising a dynamic alternating current to from 10,000 to 20,000 volts, and a condenser be placed across the secondary terminals the sparking at the gap J is enormously increased by the air blast, both in strength and frequency, so that a few turns of coarse copper wire placed in the circuit will develop an extraordinary self induction capable of lighting a number of incandescent lamps, as shown in Fig. 8, where the lamps offer a non-inductive path for the alternating wave. Without the air blast the lamps will not glow. Although the wire at A be a quarter of an inch thick, and only 15 or 20 turns in a coil six inches in diameter be employed, the self-induction is sufficient to cause an illumination of the lamps. A secondary circuit placed in inductive relation to this coil is strongly affected, a single turn in such a circuit as indicated in Fig. 9 being sufficient to light a lamp requiring 25 volts and two amperes of current. The tremendous voltage and frequency of the current is indicated in Fig. 10, where a lamp L fed by a few turns placed in inductive relation to coil A will be illuminated, although shunted by a heavy copper wire W. The effects described in Figs. 8, 9, 10, do not occur unless the air blast is employed to increase the frequency of discharge. In a similar arrangement of coil shown in Fig. 11, thick sparks pass at D through a space three-quarters of an inch in length, although the coil A has but ten turns and the coil B but 20, both coils being of a very heavy copper wire made into a coil six inches in diameter. In Fig. 12 the coils are connected together through a sliding contact and arranged so as to discharge in series through a bank of lamps L. The

(Continued on page 44.)

ELECTRIC LIGHT NEWS

—— Bellefontaine, Pa., wants electric lights.

—— Epping, N. H., is to have electric lights.

—— Chesterton, Ind., wants electric lights.

—— Manchester, O., will have electric lights.

—— Bordentown, N. J., wants electric lights.

—— Cape Vincent, N. Y., is talking electric light.

—— Lake City, Minn., wants an electric light plant.

—— West Point, Ga., is looking up electric lighting.

—— Homer, Mich., wants electric lights in her streets.

—— Hillsboro, O., will erect a fine electric light plant.

—— Chestertown, Md., is talking of an electric light plant.

—— Benson, Minn., will want electric street lighting soon.

—— Girard, O., will adopt the electric light for its streets.

—— Chester, Pa., is tired of "ark" lights and wants *arc* lights.

—— Wilbur, Wash., will probably have electric lights this year.

—— Kalamazoo, Mich., is figuring on a municipal lighting plant.

—— Westfield, N. Y., wants to vote on putting in a village plant.

—— Middleboro, Mass., wants to establish a town lighting plant.

—— Monmouth, Ill., is discussing the electric light for its streets.

—— Sycamore, Ill., will advertise for bids on electric street lights.

—— The West Point Military Academy is to be lighted by electricity.

—— St. Peter, Minn., is agitating the subject of electric lighting for its streets.

—— Marlboro, Mass., is investigating the subject of municipal electric lighting.

—— Whitman, Mass., has voted to buy and operate a town electric lighting plant.

—— Crawfordsville, Ind., wants to enlarge the capacity of its electric light plant.

—— There is considerable talk of starting an electric light plant for Lisbon Falls, Me.

—— The Illinois Electric Material Company, of Chicago, has made an assignment.

—— O. M. Anderson is arranging to establish an electric light plant at Redlands, Cal.

—— Framingham, Mass., is considering the question of electric lighting on its own account.

—— The electric light question at Findlay, O., will soon be submitted to vote of the people.

—— The Valdosta, Ga., Electric Light Company declared a semi-annual dividend of six per cent.

—— The Fall River Electric Lighting Company has declared a quarterly dividend of 1½ per cent.

—— There is a movement on foot to place an electric light plant in the buildings of the Boston University.

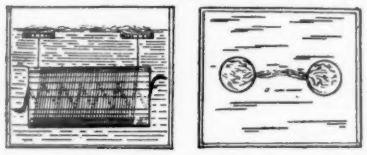
—— The South Pittsburg, Tenn., Electric Light and Power Company have declared a 10 per cent. dividend.

—— The annual report of the Mather Electric Company showed eight per cent. earnings on the capital stock for the year. Mr. A. D. Claflin was elected general manager.

PROF. THOMSON'S LATEST WORK.

(*Continued from page 43.*)

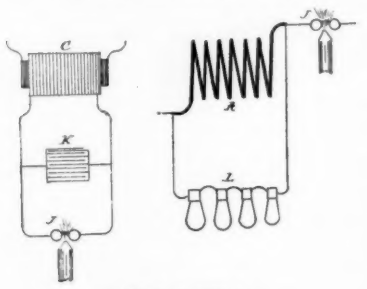
coils having respectively about 12 and 20 turns of copper wire a quarter of an inch thick the lamps may be brilliantly illuminated, the effect being varied by adjusting the sliding contact. The coils may be arranged in multiple arc as shown in Fig. 13 and a lamp or lamps be placed in shunt to part or all of one of them. The effects are increased by an increase in amount of condensing surface at K. More than one spark gap J may be employed as indicated in Fig. 14; the potential is thus subdivided and a number of air



FIGS. 5 AND 6.

jets may be brought to bear upon the several gaps thus permitting a more moderate air pressure to be used. In closing an admirable report of the experiments from which this description has been compiled, Professor Thomson observes—"The ratio of induction between coils A and B seems to be approximately that in an ordinary transformer, and while it is very difficult to estimate from the length of spark alone the actual voltage existing, yet it is certainly true that very many thousands of volts potential difference exist between the terminals during the passage of such sparks as seven inches and eight inches in length. The striking distance, however, appears to increase much more rapidly than the potential and if the law holds good it would appear to be easy to secure sparks of very great length by extending the scale of my experiments. It may be remarked in reference to striking distance that it is a question whether there is not a certain potential which from a certain sized terminal will strike at any distance. It would appear that in order to prevent the discharge from passing into the air either in the form of a brush or a discharge connecting the terminals, the terminals themselves should be made in the form of larger and larger poles kept perfectly smooth the higher the potential worked with, and that for voltages as high as 200,000 or 300,000 terminals tipped with small balls would act practically as points and allow discharge into the air in the form of a brush discharge, if this potential could not actually cause a leap between the terminals."

The method followed by Professor Thomson for increasing the frequency of an alternating current by simply directing a blast of air at a sparking point in its circuit is beautiful in its simplicity, and shows with what ease results may sometimes be accomplished which at first glance seem to be impossible. A limit to the frequency of waves developed by dynamic induction as in dynamo electric machines is soon reached, at least in those



FIGS. 7 AND 8.

types of machines heretofore used. If the air blast method of increasing the frequency be applicable to current tensions suitable for commercial uses, a system of lighting utilizing Professor Thomson's plan would seem to be ready for immediate realization. The system however, would seem to require that the transformed current of ultimate frequency be developed closely adjacent to the point of consumption, for the self-induction of even a copper circuit of such a length as would be required for municipal distribution would probably bar its transmission over a line circuit. The experiment shown in Fig. 10 shows how great is the choking action of self-induction even in a few feet of thick copper wire. A series of tests upon the amount of light generated for energy consumed would be highly valuable in comparing the relative efficiency of a transformer working upon this plan and the ordinary plan where the transformed current is coordinate in frequency with the inducing current. Perhaps it will be found that as the ratio of frequency of induced to inducing current increases, the amount of luminous energy also increases. These experiments furnish wholesome food for reflection and a careful consideration of them suggests numerous seductive lines of further investigation attractive not only from a scientific standpoint but for the assurance they offer of practical results,—the kind most highly appreciated in the present industrial age.

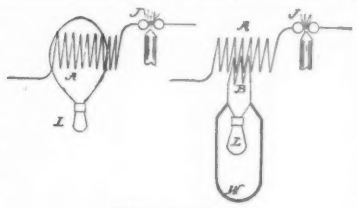
The Thomson-Houston Company's Big Order.

The order recently placed with the Thomson-Houston Company by the Brooklyn Street Railway Company for the equipment of electrical service is the largest ever received by the Thomson-Houston Company, and it will probably be a year before the contract is filled.

The first order from the Brooklyn Street Railway Company is for 1,200 motors and will aggregate about $1,500,000, not including the generators, trolleys, etc. The motor department of the Thomson-Houston Company, it is understood, has all the business it can do for the next five months, and has unfilled contracts now for about 1,900 motors.

The American Engine Company.

A representative of the ELECTRICAL REVIEW recently visited the works of the American Engine Company, which are located at Bound Brook, N. J., and was received there by Mr. Elmer Stillman Smith,



FIGS. 9 AND 10.

the inventor of the American high speed engine. While on the train, just before reaching the station at Bound Brook, can be seen without difficulty the sign of the American Engine Company on this concern's extensive plant, and the momentary impression while passing is to the effect that there lies a thrifty concern. For years past, Mr. Smith has been carefully experimenting, at the expense of time, labor and cost, on his theory as to what a high speed engine should be, and a year ago his investigations were so far rewarded by success that it was necessary to definitely settle upon a home in which to manufacture this engine. The American Engine Company were not slow to see the advantages of selecting Bound Brook, as the Lehigh Valley and Central Railroad of New Jersey render complete shipping facilities. A tract of 235 acres of ground was purchased on which were factory buildings, several of which have been utilized, others being torn down as useless and replaced by modern structures. It is the purpose of this company to so improve the section of the town in which their plant is located that its attractions will entice people seeking country residences to permanently settle in Bound Brook, and indeed, extensive grading, sewering and laying of water mains, are already under way. When the work is fully completed, electric lighting will be furnished from the factory and eventually this concern bids fair to furnish the light for the whole town of Bound Brook.

Mr. Smith, in his investigations, so radically departed from the customary design of the present engine that it became necessary, in order to obtain the best results, to have special tools made for the construction of his engine. This, of course, occasioned great delay and expense, as well as giving the tool makers throughout the country the benefit of Mr. Smith's valuable suggestions. After a year of careful testing and the manufacturing of special machinery this concern is now ready to begin actively the manufacture of their engines. The first engine built by Mr. Smith in experimental work now runs their entire plant and does surprisingly well the work required.

Electric Tanning.

A recent issue of the *Shoe and Leather Review* contains the following interesting article on electric tanning, translated from *La Lumiere Electrique*:

The principle of electric tanning is this: The electric current passes through the hides immerged in the tanniferous solution made of ordinary extracts, oak, chestnut, hemlock, etc.

Tanning is the absorption of tannin by the hide; it is quickly done under these conditions.

As many tanners are incredulous we think it is useful to describe this new branch of electric industry, as there have been late extensions and improvements.

The growth of electric tanneries is the best proof that the electric process is practical and should become popular.

It is asked, "How does electricity act when the tannin is absorbed by the hide? How does it hasten the operation?"

We know that electricity draws the tannin liquid from one electrode to the other; this liquid passes through the hide and leaves the tannin in its cells; this tannin combined with the hide renders it imputrescible, which constitutes leather.

The phenomena called by Hittorf the carrying of the ions in the electrolysis, enables us to make this hypothesis. The ions are displaced in the electrolyte, at different speeds, and give birth to mechanical phenomena, as M. Bouty has shown in his chemical experiments. This mechanical phenomena, this increase of pressure of the liquid at the surface of the hide, forces it to open its pores, and the diffusion of the liquid is made under pressure, therefore, quicker than by any other process.

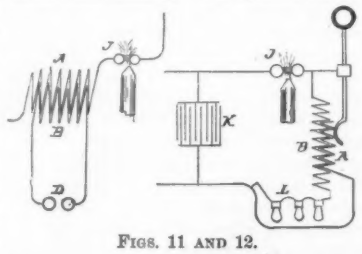
Ordinary tanning takes a long time, because the tannin juice works slowly. The role of electricity is then to hasten this diffusion. That is the first hypothesis.

But if it is transported, and if it is electrolyzed, there is no gas disengaged while the current passes. The water is not decomposed; the tub is closed and they have never observed any increase of pressure during the operation; there is only the heating of the mass. However, we should remark that the liquid is a very poor conductor, the hide a good conductor of electricity; the current must pass through the hide, or, again, the hide forms the electrodes.

Now, its structure; the state of the service is modified by the phenomena of polarization; it is, perhaps, by the tension resulting from the polarization that we should attribute the easy penetration of the liquid into the pores of the hide, for the electro-capillary phenomena should certainly enter into the act of tanning. That is a second theory.

But theories do not matter much; what should be considered is the result obtained. Now in four days they can tan a hide which takes 10 or 12 months by the ordinary process of tanks. This result is obtained by the electric process of Messrs Worms and Bale. We will describe the process and material necessary.

The tub is cylindrical (11 ft. 4x7 ft. 11), it is made of wood and turns around a horizontal axis. The rotation during the passage of the current seems necessary to cheapen the operation, but the turning should be slow. During the turning the hides strike against the walls of the tub; pegs in the walls prevent the hides from sticking. The dynamo current



FIGS. 11 AND 12.

is connected to the two extremities of the rotating axles by brushes from the collectors from which proceed the electrodes. These electrodes are composed of eight large copper wires, which enter the tub. These wires are laid symmetrically upon the inner circle at the base of the cylinder throughout its whole length to the opposite base, which also carries a like number of wires. The interior lateral surface of the cylindrical tub is carpeted with 16 wires, alternately positive and negative; the two bases have their eight wires proceeding from the center. The electric current can then flow in every portion of the interior of the tub filled with hides and liquid.

The electric action is uniform in all parts of the apparatus.

The tub holds 700 to 800 kilogrammes (1,400 to 1,600 pounds) of hides, 1,500 to 1,800 quarts of solution; for one kilogramme of hides, one kilogramme of extract at 20 degrees Baume.

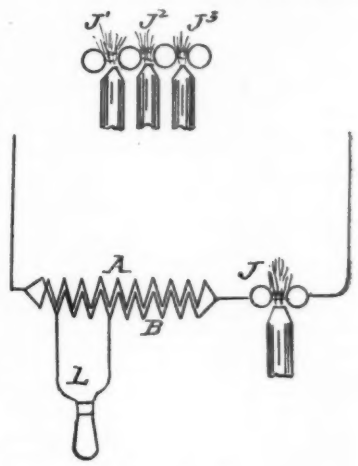
For reasons that we cannot explain, they add to the tannin liquid a small quantity of essence of turpentine.

The working current in the tub has an intensity of ten amperes at a tension of 70 volts. The time varies from 24 to 100 hours, according to the hides. The current is reversed every 12 hours by a simple switch, to regulate the wear of the copper electrodes, the positive wires wearing faster than the others.

The temperature, current and rotation must be watched if it gets too warm, and let the apparatus cool. This is followed until the tanning is finished.

The electric tanning of Messrs. Worms and Bale is now employed in England by the British Tanning Company. They have installed ten tubs resembling those described. These ten tubs produce annually 1,600,000 pounds of tanned leather. They estimate on an average 160,000 pounds of leather as the annual production of one apparatus. The motive force necessary to run the manufactory is 40 horse-power.

In France, the *Society Brion and Dupre*



FIGS. 13 AND 14.

have four machines that we have seen operate for the past two years. In the tannery of the *Glaciere* they have six machines, which corresponds to a production of nearly 1,200,000 pounds of leather prepared by electricity.

We believe other French tanneries use the electric process, but fear to frighten away their customers who scorn all new improvements, so they give it no publicity. In Portugal, two electric tanneries are installed at Porto and at Braga, with new machines producing 1,400,000 pounds of coarse leather.

They are now constructing in Madagascar an electric tannery to tan the hides of beeves whose meat is preserved. But where the process would seem to have great success is in countries producing the hides, in Brazil, the Argentine Republic, and in Uruguay.

One electric tannery is already operating in Brazil, another will soon commence manufacturing. This one is established 12 kilometres from Rio de Janeiro, at Buena Vista, and covers 51,025 square metres. They have installed 100 machines with a motor fed by two steam engines of 250 horse-power each. The annual production of this tannery will be about 140,000,000 pounds of leather.

The shortened time is not the only advantage; the electric process is more economical than the old system; it employs less costly material and much less hand work. Also, the material (dynamo and tubs) necessary to an annual production of 1,600,000 pounds of leather does not exceed 40,000 francs ($8,000).

The material is simple and cheap, moreover, the use of the electric process presents an economy of nearly 0.20 francs (4 cents) per kilogramme (about two pounds) of hides upon the price of ordinary tanning, which makes an annual production of 80,000 kilogrammes (160,000 pounds) the product of one apparatus, a profit of 16,000 francs ($3,200).

These are the advantages of electric tanning.

Business men have established that leather electrically tanned is of a quality as good if not better than ordinary leather. This important point established, the following table shows in what proportion the time of tanning is shortened:

Hides.	Duration of tanning. Electric.	Ordinary.
Light hides	24 to 32 hours.	3 months.
Heavy hides	48 to 60 "	4 to 6 "
Light cow and horse.	72 "	8 to 10 "
Heavy and medium beef	84 to 96 "	10 to 12 "
Heavy beef	86 to 108 "	12 to 15 "

Like heat, electricity facilitates reactions, permits the better and quicker manufacturing of many products, and there are many to search for and to be found in its application to chemical industry.

"Alternate Current Motors."

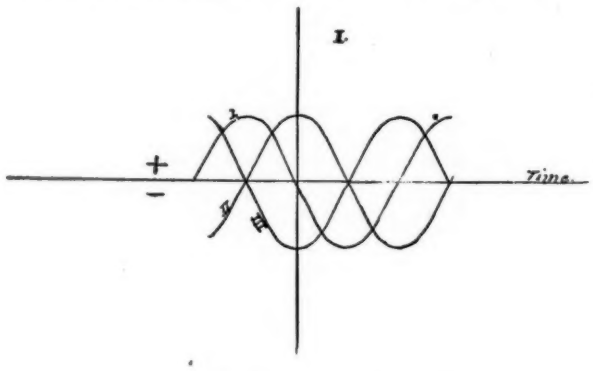
BY WILLIAM STANLEY, JR., BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, AT BUFFALO.

The historian who shall collect the data necessary to trace the rise and growth of the alternating current motor will find that the subject has been pursued by men of science in all parts of the civilized world, and he will be obliged to chronicle the fact that, up to the present year, no thoroughly practical motor system has been worked out. The various plans suggested by inventors and by engineers may be classified into three types; they are: First, motors operating in synchronism with the current alternations, having a field magnetization, produced by continuous currents with alternate currents applied to the armature circuits, a type originally demonstrated by Hopkinson, in 1883; second, motors actuated by the inductive effects of a rotating field upon closed armature circuits, first suggested by Mr. Tesla, in 1887, and, third, motors operated by alternate currents, in both field and armature, constituting one of the types investigated by Mr. Kelly and myself. As far as I know, the first work on alternate current motors in this country was undertaken at Great Barrington, 1886 and 1887, when I designed and built a synchronous motor, and a motor acting under the repulsive currents obtained by periodically short circuiting armature coils, while they were under induction from the field. One of these motors was designed in January, 1886. Professor Thomson, in 1887 and 1888, also produced motors of this type, and, what was of still more importance, he read a paper before the Institute of Engineers memorable for the clearness with which he treated the subject.

In order to more clearly explain the troubles found in designing these and other alternating current motors, I wish to call your attention to two of the properties possessed by circuits traversed by alternate or variable currents. When dealing with continuous currents, we are accustomed to consider that the resistance of a circuit is determined by the area and length of the conductor and by the specific material composing it. In dealing with alternate currents, it is desirable to extend the definition of the term "resistance" to a fuller meaning. The term "resistance," as you all know, is that property of a circuit which determines the amount of electrical energy disappearing per unit of current. The value of this property or "resistance" being obtained when the energy in circuit is divided by the square of the volume of current flow.

When steady currents occupy a circuit, the resistance value is confined to the conditions which exist within the conductor, viz., the "resistance" is proportional to the length of the circuit, inversely proportional to its area, and dependent upon the kind of material employed. When variable or alternate currents are applied to a circuit, the resistance proper may not be confined to the interior of the conductor, but may extend to its surrounding neighborhood, for, with these changing currents, work may be done outside of the conductor as well as inside of it, and, as the losses by hysteresis and by induced currents cause a disappearance of electrical energy, they may be defined in terms of the current flowing and a resistance factor. When alternate currents are used, this factor is always greater than when steady currents flow, and while in particular cases the disappearance of electrical energy taking place outside of a conductor may be small, there are cases in which the energy lost outside far exceeds the loss within the wire itself. Another point may be noticed. We are accustomed to think of the resistance of a wire as a fixed quantity; we say, a circuit has ten ohms resistance, and we are in the habit of thinking that this value of ten ohms is approximately constant and independent of the current flow. While this supposition is true for steady currents, it is not true for those of changing value. If the conductor carrying an alternate current is of small section, less than one-quarter of an inch diameter, the internal resistance of the circuit remains nearly constant for alternate currents of the frequency we are accustomed to handle, while the external resistance, if I may be allowed to use such a term, increases with an increase of current and may increase as the square of the current, or faster. While I am aware that this treatment of the term "resistance" is not in ordinary use, yet it is quite orthodox; it has been defined by the mathematicians, and its use may be justified, as it is often instructive in comparing the losses taking place within and about a conductor occasioned by the flow of alternate currents. In designing alternate current motors, for instance, the loss of energy exterior to the circuits has to be very carefully watched; for example, an alternating motor armature wound in the ordinary manner might carry one ampere of current with very little loss other than that due to its interior or ohmic resistance, while ten amperes might cause a loss exterior to the wire by hysteresis and eddy currents several times the ohmic loss in value, or the exterior resistance might become so great as to practically prevent the flow of current to the value desired.

The other property of a circuit carrying an alternate current, to which I wish to allude, is its so-called inductance, which is the property of inducing upon itself an electromotive force. The electromotive force thus produced combines with the other electromotive forces in circuit to determine the *direction and value* of the current at any time. It is not necessary for the purposes of this paper to trace out just why or how it happens that these electromotive forces are developed, or why they do not coincide



$$\sqrt{(\text{Applied E.M.F.})^2 - (\text{E.M.F. of Self Induction})^2} = CB$$

$$\sqrt{(300)^2 - (250)^2} = 165 \text{ Volts.}$$

FIG. 1.

in phase. By looking at the printed sheet, Fig. I, you will find the diagrams which illustrate the phase differences of these electromotive forces; that marked I is the electromotive force in a circuit which urges the current against the resistance of the circuit, whether the resistance be within or about, or both within or about, the conductor. The curve marked II indicates the relative position or phase, that is, time of flow of the electromotive force of self-induction, which, as you see, is to the right of the first electromotive force, and, lastly, you will find the phase of electromotive force developed upon a condenser when attached to a source of alternate currents.

For the present it is only necessary to notice that two of these electromotive forces, II and III, have their maximum and all corresponding values at the same time, as, for instance, at the time C, II and III are opposed in direction, A being + direction, B being − direction, while the maximum values of each fall upon the same time line.

Let us now briefly examine the various types of motors that have been suggested, and which I have classified in three types.

It is well known that if an alternating dynamo be run until its speed of alternation or frequency is approximately the same as that of the generator from which it is to be supplied, and, if its field is properly magnetized, it can be coupled to the generator by simply closing a switch; it will then fall into step with the generator and will take load and behave in a very proper manner; the trouble is to get it into step without employing costly or complicated appliances. If one attempt to start such a machine by commutating the current in the ordinary manner, he will find that the current will refuse to flow in the field circuit, the inductance of the circuit keeping most all the current out. How to start a synchronous motor is a problem still unsolved, but Mr. Kelly and myself believe that we have found a solution.

It is not to be understood that all dynamos will run as synchronous motors with equal satisfaction, for while the machines made in this country will so run, they are not to be compared, for this or multiple connected service, with the Mordey machines made in England, which, by the way, I consider to be the best designed alternators yet produced. The reason why the Mordey machines excel as synchronous motors is, that the inductance or self-induction of the armature circuit is so low that the slightest tendency to fall out of step is instantly corrected by the necessary current flowing in the armature.

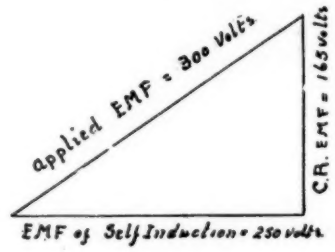
If one attempt to couple two or more of our American alternators in parallel (I refer to surface wound machines), he will find that a large false or useless current will surge to and fro between the armature circuits; this false current is due to the fact that when two alternators are put in parallel there are always short intervals of time during which one machine leads and does work upon the other; this interchange of current between the machines tends to bring them into more perfect step. Mr. Mordey's machines may be said to be always alert to correct any difference of phase, in fact, they may be imagined to correct each other at the first intimation of the lagging machine, while the American machines allow the laggard to fall a considerable distance behind before the necessary correcting current passes.

While many inventors were eagerly following their various lines of investigation for the purpose of producing an operative motor, Mr. Tesla had quietly worked out a new solution of the problem on an entirely novel basis, by inventing the rotating field, that is, the field produced by shifting magnetism and producing it by alternate currents. Mr. Tesla's motor is so simple and so beautiful in theory that many have doubtless wondered why it has not been brought into general use. If I correctly understand the subject, it has not been commercially adopted because of the difficulties in operating it at the frequency generally in use in this country, viz., 130 ~ p. s., and especially because thus far special generators and circuits having phase differing currents must be employed; there have been many attempts to subdivide alternating currents into two or more currents differing in phase. Special arrangements of condensers for producing phase differences from a single source of supply have been worked out by M. Leblanc in France and by Mr. Kelly in this country. As regards the motor itself, there are two drawbacks to its use which have not thus far been entirely removed; they result from the inductive effects of the currents upon themselves and upon each other.

To understand this matter in a practical sense, let us assume a Tesla motor having 300 pounds of iron in its field and armature to be magnetized; suppose it be supplied with a 16,000 alternate current at 300 volts pressure. We have 300 volts then applied to each of the two field circuits. We can count on the motor being magnetized to at least 20,000 C. G. S. lines per square inch of iron, which, with a loss of one watt per pound, would then represent an external resistance loss, that is, a loss outside the wire, of 300 watts, and a resistance of $\frac{300 \text{ watts}}{C^2}$. In this case the internal resistance of the copper coils may be made low and may be neglected.

Now, it is evident that the magnetization produced in the field will react upon the field coils and will develop an electromotive force of self-induction, and this electromotive force, as shown in Fig. I, will be 90 degrees or half a semi-period from the electromotive force urging the current against the resistance; let the value of this induced electromotive force be 250 volts, then the electromotive force urging the current against the resistance will be found by

$$\sqrt{(\text{applied E.M.F.})^2 - (\text{E. M. F. of Self-Ind.})^2} \text{ or } \sqrt{300^2 - 250^2} = 165 \text{ volts.}$$



$$R = \frac{\text{Watts inside of wire} + \text{Watts outside of wire}}{C^2}$$

FIG. 2.

That is to say, that of the 300 volts applied, 165 volts are used up in urging current to magnetize the motor when it is doing no work, and 250 volts are available for inducing currents in the armature. If, as we have assumed, the lost due to hysteresis is 300 watts, then the current flowing would be $\frac{300 \text{ watts}}{165 \text{ volts}} = 1.8$ amperes, and the resistance external to the wire $\frac{300}{(1.8)} = 92$ ohms.

I do not mean to say that these conditions are actual or cannot be improved; they ought to be. I present them simply to show that, with this type of motor, the full electromotive force employed is not available, as in the example when, with 300 volts applied, but 250 volts are available and 165 volts are lost.

Moreover, it is necessary that a strong field magnetization should be developed in a motor in order that a powerful starting torque may be had; as a consequence, the field circuits of this motor must be composed of a comparatively *small* number of turns of wire (the flux or magnetization in an alternating magnet being inversely as the number of turns with a given applied electromotive force and with a magnetic circuit of given reluctance). It might also be shown that the value of the field producing current in these motors, viz., the current required to run the motor empty, is largely dependent upon the air gap between the field and armature, the current at no load being greater as the clearance between the field and armature is increased. The Tesla motor then must necessarily have a false or lagging current at no load, and must expend considerable energy in the production of the rotary field by hysteresis loss, until someone, and Mr. Tesla as likely as any one, shall find an iron without hysteresis and an air gap that does not require magneto-motive force. I understand that these motors require about .6 of the full load current when running free with a factor of lag of about .7, so that the actual per cent. of energy required to run them free is, approximately, .6x.7 xen = 42, or, say, 40 per cent. of their full load energy. This is a rather serious matter when viewed from the standpoint of the station manager, for if the motor service requires .6 of its full load current to run free of work, then evi-

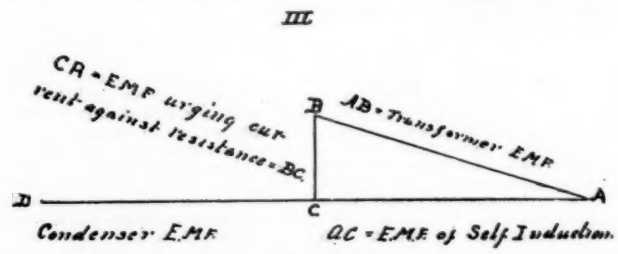


FIG. 3.

dently .6 of the station capacity must always be in operation. There is another slight trouble with these motors, resulting from the fact that the co-efficient of mutual induction does not keep up as the motor is loaded; this may be explained by saying that the flux and, consequently, the electromotive force developed in the short circuited armature coils, decreases as the motor is loaded; this decrease of induction affects the speed of the motor, causing it to fall off with load, while it requires a larger current in the field to furnish an increased amount of work; both of these difficulties, however, are very largely determined by the design and calculation of the motor itself, and may be brought within working limits. I see no reason why this motor may not be made successful and operative by proper designing and careful study.

The problem before those studying the alternate current motor is, however, entirely independent of these difficulties. Had we a reliable means of dividing an alternate current into two currents having the proper difference of phase, Mr. Tesla's motor would be made available and would be of great commercial value. Mr. Kelly and myself have found an entirely novel and complete solution to the problem. As far as we can discover, it has never been attempted by any other experimenters. By the use of a very simple invention, we are able to draw from a single transformer secondary two phase differing currents, having any differences of phase we elect. These currents maintain their phases, that is to say, times of flow, independent of the amperage of the current and of each other. We can apply our invention at the station, splitting the primary current from the dynamos into two phase differing currents, or we can lead the primary current through a transformer and split the secondary into two components.

I regret that I am unable to disclose the methods we adopt, but I hope to be able to publish our results shortly. Our method will then allow us to run the Tesla motors from the same circuits and by the same generators that we now employ in incandescent alternate current lighting. The Tesla motor for the past five years has been waiting for one thing only to develop it, viz., a current splitter, and we have found one.

Mr. Kelly and I have invented what we call a "condenser motor," which differs radically from either of the above mentioned types. The problem which we have had in mind was to construct a motor which should be operated by existing alternate currents in exactly the same manner that we operate an ordinary motor when supplied with continuous currents; to do this, it is necessary to construct a motor whose circuits do not possess (effective) self-induction, or, to put it in another way, it is necessary to take away from the alternate current circuits the effects of the electromotive forces induced in them by their own currents, which renders unavailable a considerable part of the electromotive force applied.

I will attempt to explain our shunt motor without the use of formulæ, illustrating the results obtained as best I can.

Our motor has a laminated sheet iron field, and may be made in any of the multipolar or bipolar types. The field winding is connected in series with a condenser to the secondary of a transformer, which, when fed from the station, furnishes the source of supply. The armature of the motor, although wound with a special winding, is substantially the same as a continuous current armature, and is surrounded by closed copper bands whose function I will describe later. The theory of the motor is, that, given the necessary magnetization and armature current, the motor will operate as well with alternate as with continuous currents. Returning to the field circuit, let us glance at the function of the condenser. If the field windings were connected directly to the transformer or source of supply we should have two electromotive forces in circuit, combining to oppose the electromotive force applied by the transformer. Let the line A-B, Fig. III, be this electromotive force, and let B-C be an electromotive force whose value is found by multiplying the current (in the case assumed) by the resistance of the circuit. By resistance is meant the internal or ohmic resistance plus the external resistance due to hysteresis and eddy currents, then A-C is the electromotive force of self-induction; the two electromotive forces, A-C and B-C, combine to always just balance the transformer electromotive force.

Now, in any operative type of motor, the electromotive force A-C will always be greater than B-C, or, simply, the opposition of A-C will be so great as to practically obstruct the flow of current in the field. If, now, we could introduce a third electromotive force, such as C-D, which should always oppose A-C, we could neutralize the effect of A-C upon the time of flow and value of the current, which, in that case, would not be opposed by any electromotive force, except C, R, or $C = \frac{E}{R}$, as in the case with steady currents. To get this third electromotive force, we insert a condenser whose capacity is so chosen that the field current will develop a potential upon the condenser terminals equal to the electromotive force A-C; if the field current

IV.

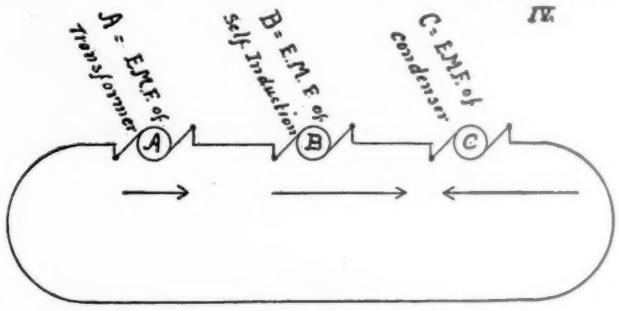


FIG. 4.

changes in value from time to time, it will change the values of both A-C and C-D (as these electromotive forces are in series connection) in almost the same ratio, and consequently these two electromotive forces, the one on the condenser and the other on the field coil, will always neutralize each other's effects, and the circuit will be left free to the current flow, as with continuous currents. Perhaps this may be made simpler by considering the resultant effects produced by a number of alternators coupled in series, Fig. IV. Let A, B and C be these generators; let them be all rigidly coupled to the same shaft, A being set on the shaft so that its armature generates an electromotive force 90 degrees away from that of B and C, while B and C are coupled to produce the same voltage at the same time and have their terminals opposed; then B and C will exert no effect upon the circuit, for they will always neutralize each other. The electromotive force of A corresponds to the transformer electromotive force; the electromotive force of B to the electromotive force of self-induction on the field coil, and the electromotive force of C to the electromotive force on the condenser. In this way we obtain the necessary current to magnetize our motor unrestrained by the electromotive force of self-induction.

The next difficulty to clear up, in order to operate our motor, is to get rid of the external resistance in the armature circuit. In order that a motor may operate economically and regulate properly for changes of load and current it is desirable that the armature resistance should be very low; the principal resistance offered to alternate currents in an armature is, as before stated, due to the work outside of the armature wire in the iron core; these losses in the iron are occasioned by the alternating magnetization developed by the armature current; to remove this loss of energy we have had to destroy most all of the armature magnetism in the following manner.

You are all aware that if a magnet core is wound with two equal coils in opposite directions and is connected with a current source, the resulting magnetism will be only that due to the difference of the winding displacement, and will be practically negligible. About our armature, see Fig. V, we place close circuited copper bands or wires, so disposed as to be parallel to the direction of current flow in the armature conductors; the currents flowing in the armature windings induce oppositely directed currents in the stationary bands, and, consequently, the armature core is surrounded by two sheets of current during each wave of current flow; the sheet of current on the armature flowing in one direction, whilst the current in the stationary bands flows in the opposite direction, thus practically preventing any magnetizing effect, and thus, also, preventing any loss by hysteresis and eddy currents in the core. Now, it can be shown that the work lost in the copper bands will be very small, providing the resistance of these bands be kept low, and we have found that this loss can be made as low as one-third of the inside or ohmic loss, a result which enables us, by proper designing, to make our armatures almost as efficient as those of the best direct current type, with small additional expense.

One other point of advantage obtained by the use of the compensating bands should be mentioned; as the cross magnetization of the armature is practically destroyed, there is no change of lead under variation of load, as there is no distortion of the field magnetism by the armature current. These results are eminently satisfactory. In describing the Tesla motor I pointed out that there was a loss of voltage, or that, of the voltage applied, a considerable portion was unavailable; in our motor 96 to 98 per cent. of the voltage applied to the armature is available, while the operating conditions are identically the same as found with a continuous current motor. It is not to be understood that the motor has an efficiency of 96 to 98 per cent. Far from it. In our small motors the losses in the field and armature will aggregate 30 to 40 per cent. In the larger types of from two to five horse-power the loss will not exceed 25 per cent., whilst in the still larger sizes the losses will be much less. The problem of the efficiency of the motor is almost the same as the efficiency of the transformer and depends in large measure on the care and skill of design.

To operate our motors it is necessary that the speed of the dynamo should remain constant; as constant as possible. If the stations will give us a definite number of alternations, and will maintain that number, our motors will behave beautifully; if the alternations change, the condenser electromotive force will no longer exactly oppose the lagging electromotive force of self-induction and the field current will change and lag either positively or negatively; mere change of electromotive force will not interfere with the operation of our motors more than it would with any continous current motor.

Fig. VI illustrates the general design arrangement of the motor system. The condenser is placed either upon the wall or under the motor in the base; the electromotive force applied to the field is about 150 volts; the armature electromotive force is either 50 or 100 volts. The electromotive force on the condenser is, approximatively, 750 volts. While this electromotive force may appear excessive at first sight, there is no real danger from its use, as a contact across the terminals would instantly reduce the potential and accidental contact is easily prevented by properly insulated wires.

There is one other type of motor to be mentioned; the series wound motor. When operating any of the ordinary types of motors by alternating currents, it is necessary that the phase of the field magnetism must coincide with the phase of the electromotive force applied to the armature circuit, that is to say, the field magnetism must arrive at its maximum value at the same instant the electromotive force applied to the armature arrives at its greatest value; for if these two values do not coincide in time, the counter electromotive force developed by the rotation of the armature will not directly oppose the electromotive force applied to the armature, but will be skewed off one side, and, consequently, will allow a false current to flow in the armature circuit. Fig. VII illustrates the point, for, suppose they do not coincide in phase, then A-B represents the maximum value of the alternating electromotive force applied to the armature, and

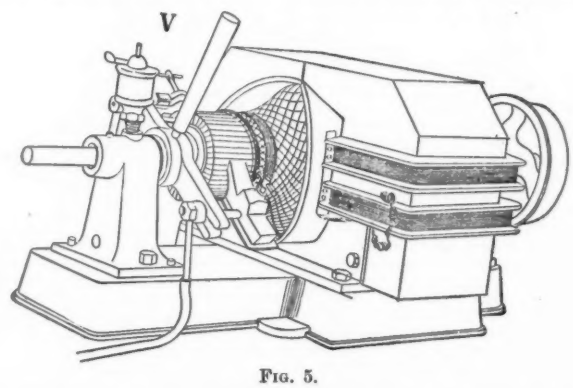


FIG. 5.

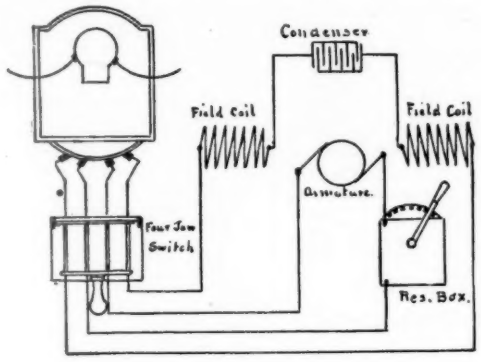
B-C represents the lagging magnetization, which, as I have stated, should coincide with A-B; consequently, B-S represents the counter electromotive force of rotation, which is, of course, directly opposed to B-C and should be directly opposed to A-B, or should occupy the position of B-E. It can be shown that D-F is the electromotive force urging the current against the resistance of the armature, or C-R, while E-F, which is smaller than D-F, would be that electromotive force, providing the magnetism B-C coincided with A-B. All this simply means that, when operating a motor by alternate currents, the magnetism in the field should coincide with the electromotive force applied to the armature; or else there will be a false current in the armature circuit; the condenser accomplishes this desired result in the shunt type of motor; in the series wound motor the magnetization necessarily coincides with the armature electromotive force, because they both accompany the same current. The series wound type of motor, then, is the simpler to deal with; let us examine it for a moment. If an alternate current source be applied to a series wound motor properly constructed with laminated fields, etc., the motor will run with feeble torque, and if one investigate the cause of this want of torque and power, it will be found at once to be due to the inductance of the motor; the electromotive force of self-induction will greatly reduce the available electromotive force applied to the motor, and consequently lower its capacity to translate electric energy into mechanical power. We have removed this deleterious effect of the electromotive force of inductance in the following manner. Fig. VIII represents a motor having its field and armature connected in series, while c is a condenser also connected in series; the distribution of the electromotive forces is given in the diagram. The transformer supplies the motor with current at 50 volts pressure, the electromotive force of self-induction located almost entirely upon the field coil is assumed to be 60 volts, the electromotive force on the condenser is, consequently, 60 volts for the current in circuit and the load on the motor, and, consequently, if the current varies, then both the condenser and self-induction electromotive forces vary in approximately the same manner, thus leaving the circuit to receive current from the transformer and to do work. In my judgment, this type of motor will be of great practical use; not only will these motors successfully handle all constant load problems, such as pumping, blowing, etc., but they will be exceedingly useful in crane and elevator work, while their service in propelling cars can hardly be estimated. In all cases where hand control is required, they can be operated as successfully as continuous current motors.

The most serious question we have met in pursuing this problem has been that of finding a suitable condenser. It may be well to state that none of the ordinary types of condensers, viz., those made of paper, paraffine, glass, mica, etc., are of the slightest use. We have found that the residual charge in all the above mentioned substances absolutely prevents their acceptance; this residual charge seems to depend upon the non-homogeneity of the dielectric and upon the want of an absolute contact between the plates of the condenser and the dielectric surface. When glass is used as a dielectric and a potential of 1,000 volts (average) is maintained upon the condenser, the glass heats rapidly until, finally, it is shattered to pieces. Condensers of glass, when raised to a potential of 15,000 volts, became phosphorescent, rapid flashes of light appeared in various parts of the glass, while they withstood the potential, which was only for a few moments. Vulcanite we find unreliable; metallic chips are always present and for this reason, if for no other, it fails to stand satisfactorily. We have succeeded in producing what we call "films" from .003 to .005 of an inch thick, which will surely stand a potential of 1,000 volts. We believe that these condensers are entirely commercial, that they will not deteriorate, while their cost per microfarad is quite low. So perfect are they, that they show but little trace of residual charge, they do not heat perceptibly when in circuit for a long time, and withstand a potential of from 2,000 to 3,000 volts with a dielectric thickness of .006 inch. The processes of their manufacture will not be made public at present.

Of the three types of motors mentioned in the beginning of my paper I have but partially described one; the other two can be worked out. We believe we know how to perfect the synchronous type; we expect to do so. The Tesla motor is perhaps the simplest of the three to work out from the beginning, but, like all such problems, it requires study and careful investigation. The so-called multiphase motors, of which much has lately been written, possess no advantage over the two phase type as devised by Mr. Tesla; in fact, the two phase motors are neither better nor worse; but the European multiphase motors appear to have been carefully designed; the relations between field and armature seem

better, and, if they possess any superiority over the American rotary motors, it is derived from these conditions rather than from any new departure in the application of the three phase currents.

Mr. Kelly and I have produced motors which are operative on existing circuits. As we have stated, our motors start at full torque, run to a definite speed and behave exactly like direct current motors under load. So perfectly does our compensating winding eliminate the electromotive force of self-induction from the armature circuit, that this circuit offers very nearly the same



VI.

FIG. 6.

opposition to alternate currents of a frequency of 130~p. s. that it offers to continuous currents; there is, therefore, little falling off of speed due to the self-induction of the armature circuit; in fact, we can over-compound the motor by its own load by setting the brushes off the neutral point of commutation, thus changing the flux through the field.

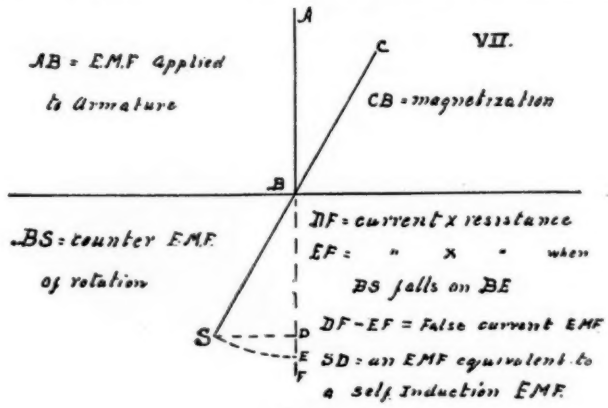
Your president has asked me to address you on the alternate current motor problem, and I presume he expects me to offer an excuse on behalf of the profession for not having placed in your hands a perfected motor adapted to your circuits before this time. I can only say that the problem has been a difficult one; there are so many opportunities offered to alternating currents to dissipate their energy, so many more than are found with continuous currents, that one has to be very keen sighted to avoid undue waste in constructing alternating machinery, but, from the knowledge already acquired, I feel convinced that the coming year will place the alternate current motor firmly on its feet, and that before the year elapses many stations represented in this convention will be testing the accuracy of the statements contained in this paper.

DISCUSSION.

Mr. Stillwell: I should like to ask one question of Mr. Stanley, and that is: In this motor that operates with a condenser, or an arrangement equivalent to a condenser, is there any faradization of the currents behind the electromotive force in the circuits? Suppose we have a long line over which to transmit power, what is the relation of the phases of electromotive force and current in the circuit from the generator to the dynamo or motor? I understand that there is little retardation, if any.

Mr. Stanley: None whatever. The electromotive force flows at the time of the impress of the electromotive force. There is no lagging, and therefore there is no false current. The product of the current in the electromotive force expresses the true energy. In all of the rotating field motors, if you want to find how much power you are using, you multiply the electromotive force and current together, and then multiply by some decimal, some factor, which gives you the relations of the power actually absorbed with the power apparently absorbed. In our motors it is not so.

Mr. Stillwell: I would like to refer to the development of the Tesla motor, and to the relation of the false current to the true current in the operation of that motor. Mr. Stanley's statement is, so far as my recollection serves me, about correct, when the motor is at full load; a motor of four or five horse-power; but the Tesla motor behaves very much like a transformer. The development and perfection of this motor, as Mr. Stanley has said, is a matter of attention and careful study of details of construction. Mr. Tesla and Mr. C. L. Scott have worked on this subject for a long time, and have brought the Tesla motor up to about the best relation that I believe is practicable with that type of motor, and that is a very good relation for certain purposes. The relation of the false current at no load is not, however, proportionate to the energy. In a transformer of the closed circuit type, when no lamps are burning on the secondary circuit, and consequently there are no currents in the secondary coil, we can obtain the true energy in the primary by multiplying the current and electromotive force by a factor, which, for the types ordinarily used in this country, is about seven-tenths. As lamps are added to the secondary circuit, the phases of electromotive force and the current in the primary tend to coincide, and at a partial load, comparatively small, they do coincide, practically, so that the product of current and electromotive force shows the true energy. In the Tesla motor the same general relation exists, and if it were posssible to operate the motor without an air gap, identically the same relation would exist. As we load the motor, the phase, the applied electromotive force coming from the generator and the current tend to coincide; and while on a motor of 15 horse power, which gives about the best results at no load, we must multiply the current and electromotive force by two-tenths instead of six-tenths, at full load we would multiply it by eight-tenths or nine-tenths; that is to say, that when a Tesla motor is turning over the false current is very large, but there is a relatively good regulation as to energy.

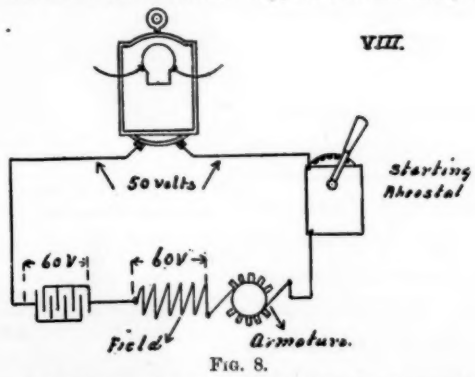


VII.

FIG. 7.

Good current regulation is very difficult to obtain, and, therefore, there is always some flow in the circuit. This does not apply to the efficiency, and the false reading is by no means as much as would be understood from the bare statement. I have been very much interested in Mr. Stanley's paper, and I am sure that all manufacturers, those connected with companies, as well as the managers and central station men, will welcome anything that is in the way of improvement over existing apparatus. As Mr. Stanley is not prepared to tell us just the arrangement he uses, it is impossible and unfair to criticise the operation of this motor. When he is ready to disclose his method, we shall be in position to say more definitely what it will probably do. At the present time it seems to me that the practical question presented is this: Assuming the case of power transmission for a considerable distance, and omitting for the time reference to the very general application of such a motor on existing circuits of small size, in the case of power transmission I think it is very questionable whether the advantages over the multiphase or synchronous type would be real. We should certainly have to pay some price for it, by using some new apparatus—a condenser or something else. If we were to transmit power from Niagara Falls to Buffalo, and were to use existing apparatus, about as good a method as we could use, we could have two satisfactory methods, one the two phase or multiphase system, and the other would be the straight synchronous system, with small starting motors to start the large ones. I think, if we were called upon to supply power to Buffalo from Niagara Falls, it would be a toss between the two methods. It would depend largely upon the amount of power to be transmitted and the potential to be employed. If it were 10,000 volts, it would be sufficiently high for a distance of 30 miles, if we were to deliver not more than 2,000 or 3,000 horse-power. It is probable that we should prefer to use two wires and two sets of insulators on each pole, rather than to run three or four wires. The advantage of the latter would be that we could start the motors with torque, so that they could be brought up to their full speed when fully loaded. The disadvantage of the synchronous is simply that starting devices must be used; but that is a small matter and a small portion of the necessary investment. The multiphase and the synchronous type, when run at full load, should be operated synchronously. I do not think there can be any doubt as to that. If we do not operate them synchronously there is sure to be a retardation of current behind the electromotive force, and the effect of that is to multiply or increase our investment in copper. The advantage of synchronism is decided; it is an advantage we should not overlook, and should not neglect. This motor will run at a speed absolutely equal to that of the generator, irrespective of load. It will not get out of step, if properly designed, unless overloaded to the extent of 100 per cent, an occurrence which is extremely improbable. If it should happen, it is easy, by means of an automatic cut-off, to protect the motor. For small motors, supplied from ordinary alternating current circuits, as now exist, a motor such as Mr. Stanley describes would have a very extensive and, I think, very valuable application. There are motors which can be used for this purpose, but there are some objections to their use. The ordinary synchronous motor can be made self-starting without great torque, but with sufficient torque to bring itself up to speed.

Mr. DeCamp: I was certainly impressed and interested in the paper read this morning and also those last night. They are very technical, however, and some of us poor fellows, who have to make use of these motors, are not as well posted on the matter as perhaps we should be. I take it that there are a great many central station men here to-day, like myself, who would just like to know the relation between electric power delivered to the customer, and paid for by him, compared with that of steam. In the city of Philadelphia the prevailing rate for steam is $50 per horse-power per year. The price, like other things, has been brought down by competition. My own judgment is that, at $50 per horse-power per year, steam power is not a profitable investment; and I think that is the general impression in Philadelphia. I have heard nothing here to-day or last night to give me any idea as to how much loss there is between the steam plant and the point of delivery and the electric plant and the point of delivery. I think information on this point would be interesting to many central station men.



VIII.

FIG. 8.

Mr. Stanley: Mr. Stillwell, a moment ago, suggested that there was a possible benefit to be derived from using a multiphase motor system. I do not believe it. Mr. Tesla, in the wonderful work that he did early on that subject, outlined the exact conditions of the operation of his motor. We do not want more than two currents of 90 degrees of phase to produce a perfectly rotating field.

Moonlight Schedule for March.

The following schedule was calculated on the basis of light one-half hour after sunset and one hour before moonset. Extinguish one hour after moonrise and one hour before sunrise. The schedule obtains for the whole of the United States.

MARCH, 1892.

Day of Month.	Light.		Day of Month.	Extinguish.		No. of Hrs.
		H. M.			H. M.	H. M.
1	P. M.	8.10	2	A. M.	5.30	9.20
2	"	9.20	3	"	5.30	8.10
3	"	10.40	4	"	5.30	6.50
4	"	11.50	...	...	...	5.40
5	...	...	5	"	5.30	
6	A. M.	1.00	6	"	5.30	4.30
7	"	2.00	7	"	5.30	3.30
8	"	3.00	8	"	5.30	2.30
9	"	3.40	9	"	5.30	1.40
10	"	4.20	10	"	5.30	1.00
11	No light.		11	No light.		0.00
12	No light.		12	No light.		0.00
13	No light.		13	No light.		0.00
14	P. M.	6.30	14	P. M.	8.10	1.40
15	"	6.40	15	"	9.10	2.30
16	"	6.40	16	"	10.10	3.30
17	"	6.40	17	"	11.10	4.30
18	"	6.40	19	A. M.	12.20	5.40
19	"	6.40	20	"	1.20	6.40
20	"	6.40	21	"	2.20	7.40
21	"	6.40	22	"	3.20	8.40
22	"	6.40	23	"	4.10	9.30
23	"	6.40	24	"	5.00	10.20
24	"	6.50	25	"	5.00	10.10
25	"	6.50	26	"	4.50	10.00
26	"	6.50	27	"	4.50	10.00
27	"	6.50	28	"	4.50	10.00
28	"	6.50	29	"	4.50	10.00
29	"	6.50	30	"	4.50	10.00
30	"	6.50	31	"	4.40	9.50
31	"	9.30	April 1	"	4.40	7.10
				Total,		180.40

The Proposed Chicago and St. Louis Railroad.

The Chicago and St. Louis Electric Railroad Company has been organized for the purpose of building and operating an electric railway system between the cities of Chicago and St. Louis, with necessary branch lines connecting with the towns and cities along the main route. It is proposed to carry passengers, high class freight, express and mail matter, and also to supply individuals and towns along the road with light, heat and power for domestic, manufacturing and other purposes.

The prospectus would indicate that this company proposes to put into practical operation the scheme of high speed electric rapid transit, 100 miles an hour being fixed as the standard rate to be maintained, which was formulated some eight years ago by the inventor of the system to be used, Dr. Wellington Adams.

The following is a list of a few of the gentlemen whom it is stated are interested in the project:

Hon. David R. Francis, governor of the State of Missouri; Hon. Seth W. Cobb, congressman for the Ninth Missouri district; I. G. W. Steedman, president of the Curtis Manufacturing Co.; Web. M. Samuel, president St. Louis United Elevator Co.; Wm. Somerville, president Missouri Glass Co.; E. S. Rowse, financial and real estate agent; Francis E. Nipher, professor of electrical engineering, Washington University, and ex-president St. Louis Engineers' Club; Prof. W. Trelease, director of Shaw's Garden; Prof. H. S. Pritchett, Washington University; Prof. G. Hambach, Washington University; Dr. G. Baumgarten, Dr. A. V. L. Brokaw, Dr. Y. H. Bond, Dr. George F. Hulbert, Dr. Enno Sander, Dr. T. F. Prewitt, Wm. H. Thompson, president Bank of Commerce; Ewing Hill, president Western Advertising Co.; Hugh Rogers & Co., Chas. W. Orthwein, Orthwein Bros., and vice-president of the Lindell Electric Railway Co.; Given Campbell, lawyer; John W. Harrison, president Shickle, Harrison & Co., iron works; Frank Shapleigh, of A. F. Shapleigh Hardware Co., and Edwin Harrison, all of St. Louis; John P. Keiser, formerly president Laclede Gas Co., and George W. Allen, president Southern Hotel Co.

KINDRED INTERESTS

The Dodge Manufacturing Company, Milwaukee, Ind., is sending out a very interesting catalogue of power transmitting machinery.

The Lunkenheimer Brass Manufacturing Company, Cincinnati, has issued a unique calendar which carries a neat representation of this company's improved "Handy" gate valve. The valve works both in practice and on the calendar.

Messrs. F. R. Dravo & Company, Pittsburgh representatives of the Ball Engine Company, Erie, Pa., have made installations of Ball engines in the following office buildings in Pittsburgh: Central District Telephone and Telegraph Building; Vandergrift Building; Schmidt Building.

The Washburn & Moen Manufacturing Company, the largest firm of wire manufacturers in the world, have recently equipped their insulated wire factory with the latest and best machinery obtainable. Their facilities for producing the best quality of bare and covered wires are unexcelled.

F. P. Little & Company, Buffalo, N. Y., have just closed a contract with the Western Transit Company for lighting their Buffalo city elevators "A & B." The contract includes a 7x12 Rice engine, manufactured by the John T. Noye Manufacturing Company, one E. I. cylindrical type Thomson-Houston dynamo, and necessary wiring and equipment for 300 sixteen candle-power incandescent lights and four arc lights, to be run from the same circuit. F. P. Little & Company are also to erect a 10x25x13 foot brick building, in which to put the plant.

Mr. A. H. England, has severed his connection with the Electric Merchandise Company, of Chicago, as secretary and treasurer, and will hereafter devote his time to the management of the International Register Company. This company has acquired the Pratt patents on fare registers and will be in a position to furnish the very best and modern registers in various forms for street car use. Special attention will be paid to improvements, and thoroughly reliable and accurate machines are guaranteed. Mr. England's office is at 435 The Rookery, Chicago.

◁ RECEIVER'S SALE ▷

On March 22d the electric light plant at Van Wert, O., will be sold at Receiver's Sale.

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Three No. 10 220 volt Edison Dynamos complete, with regulating devices and in perfect order, for $700 each.

One Hawkeye 220 volt dynamo 200 amperes for $500.

One Hawkeye 220 volt dynamo 150 amperes for $350.

Three Baldwin Steam Dummy Locomotives, from eight to eleven tons, two for $500 each—one good as new for $2,500, all of them were in daily use last summer.

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Planers, 16 in. x 16 in. x 3 ft.; 20 in. x 20 in. x 4 ft.; 24 in. x 24 in. x 6 ft.; 30 in. x 30 in. x 6 ft.; 36 in. x 36 in. x 10 ft.; 42 in. x 42 in. x 12 ft.; 72 in. x 60 in. x 15 ft.; 72 in. x 60 in. x 20 ft.
Friction Shapers, 15 in., 16 in., 20 in., 22 in., 32 in.
Crank Shapers, 6 in., 8 in., 10 in., 12 in., 15 in., 16 in., 20 in., 24 in., 28 in.
Screw Machines, Nos. 1, 2, 3, 4, with or without Wire Feed.
Screw Machines, Nos. 5, 6, 7, 8, Power Feed.
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5 Lincoln Pattern Millers, No. 2.
Hand Millers, Nos. 1 and 2. 3 Cam Cutters.
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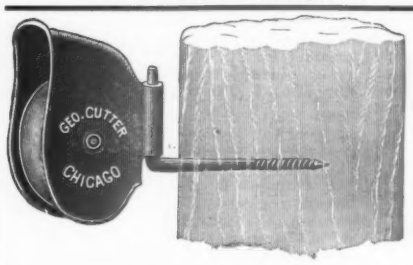

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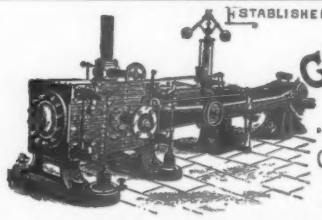

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON FEBRUARY 23, 1892.

469,515 Electric machine; Michael Von Dolivo-Dobrowolsky, Berlin, Germany, assignor to the Allgemeine Elektricitats-Gesellschaft, same place.
469,522 Electric cable; Hammond V. Hayes, Cambridge, Mass.
469,538 Process of and apparatus for electroplating the hulls of vessels; Alexander D. Buchanan, Long Island City, N. Y.
469,649 469,650 Signal device for telephone pay stations; William Gray, Hartford, Conn., assignor of one-half to Chas. Soby, same place.
469,652 Automatic advertising apparatus; Wm. C. Jennings, Camden, N. J., assignor to the Jennings Machine Co. of New Jersey.
469,656 Electric lighting system; James F. McElroy, Albany, N. Y.

MARCH 2, 1892.

469,672 Electro-magnet; Andrews D. Ayres, Kalamazoo, Mich.
469,706 Telephony; William C. Lockwood, New York, N. Y.
469,712 Device for controlling electric motors; Albert L. Parcelle, Boston, Mass.
469,717 Power transmitting mechanism for cars; Enoch Prouty, Chicago, Ill., assignor to himself and Edwin J. Noble, same place.
469,723 Underground electric conduit; Edward P. Robbins, Cincinnati, O.
469,725 Dynamo-electric machine; Elmer A. Sperry, Chicago, Ill.
469,730 Journal box; William O. Wakefield, Lynn, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.
469,745 Non-interfering fire alarm telegraph box; Frank F. Loomis, Akron, O.
469,750 Automatic trolley catch; Stephen A. Shepard and Frederick P. Lang, Allegheny, Pa., said Lang assignor of one-fourth to said Shepard.
469,765 Distributing box for cable systems; Charles H. Wilson, Chicago, Ill., assignor to the American Bell Telephone Co., Boston, Mass.
469,782 Telephone transmitter: Joseph C. Goulding, Cardiff, assignor to Woodhouse & Rawson United, Limited, London, England.
469,792 Electrically heated smoothing iron; Willis Mitchell, Malden, assignor to the Butterfield-Mitchell Electric Heating Co., Boston, Mass.
469,796 469,797 Galvanic electric plaster; John W. Shults, Wichita, Kan.
469,799 Electric locomotive; Thomas L. Willson, Brooklyn, N. Y.
469,800 Electric meter; James J. Wood, Fort Wayne, Ind.

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